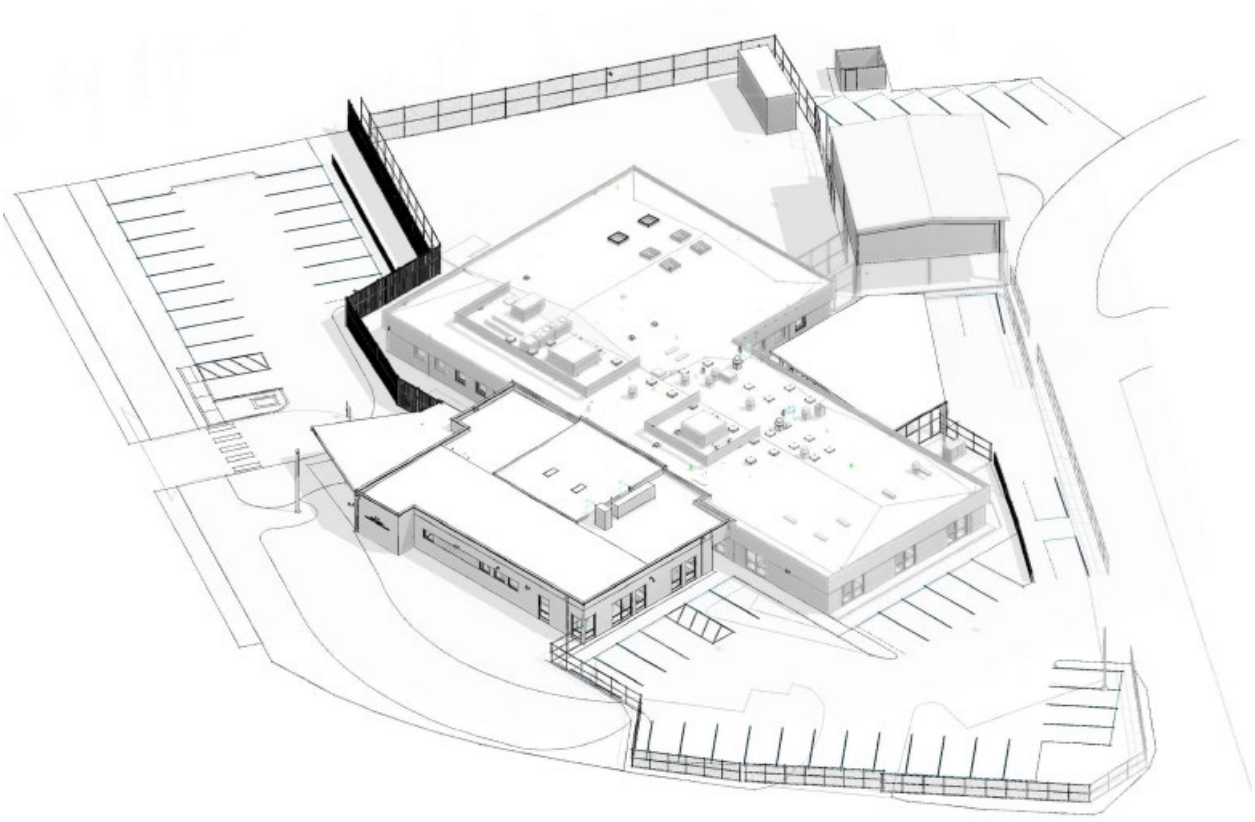


# JUVENILE COURT RENOVATION PROJECT
# LEWIS COUNTY

**LEWIS COUNTY FACILITIES DEPARTMENT**
351 NW North Street
Chehalis, Washington 98532

## Project Manual – Construction Set
Volume 2 - Divisions 21 - 33

**July 22, 2021**

KMB Project No. J2037C

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# Project Manual

Volume 2 - Specifications (Divisions 21 – 33)

# JUVENILE COURT RENOVATION PROJECT
# LEWIS COUNTY

**KMB Project No. J2063**

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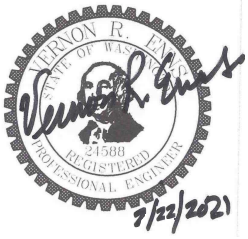
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### 1.01 SECTION INCLUDES

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**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes design and construction of complete automatic wet **and** dry fire suppression systems for the existing building and the addition.

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.

### 1.02 QUALITY ASSURANCE

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

B. Authorities Having Jurisdiction (AHJs):
   1. Chehalis Fire Department.

C. 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. FM 1035, Standard for Nitrogen Generators
   14. NFPA 13, Standard for the Installation of Sprinkler Systems.
   15. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
   16. NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
   17. NFPA 70, National Electrical Code.
   18. NFPA 72, National Fire Alarm Code.
   19. NFPA, Automatic Sprinkler System Handbook.
   20. UL 268, Standard for Smoke Detectors for Fire Alarm Signaling Systems.
   21. UL 864, Control Units and Accessories for Fire Alarm Systems.
   22. UL 1481, Power Supplies for Fire-Protective Signaling Systems.
   23. 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.

D. 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.

E. 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.

**1.03 SYSTEM DESIGN CRITERIA**

A. Survey site prior to submitting bid. Comply with requirements in Section 230500.

B. 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.

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

D. 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 combustible and non-combustible.
   3. All ceiling spaces.
   4. Attic spaces.
   5. Mechanical rooms.
   6. Electrical and telephone rooms.

E. 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.

F. Obtain latest water supply engineering test data prior to design. Include 10 percent safety margin in system design. Fire flow test results as follows: Fire flow tests performed on 4/14/2021 for the existing fire hydrant at the front of the existing Lewis County Juvenile Facility resulted in 91 psig static pressure and 68 psig residual pressure at 1,278 gpm.

G. 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.

H. 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.

**1.04 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. Alarm and signal devices.
   5. Building fire alarm system interface.
   6. Piping specialties.
   7. Nitrogen Generator System
   8. Corrosion Management Products

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 and sufficient extent of existing 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, 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. 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.

E. 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.

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

G. 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.

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

## PART 2 PRODUCTS

### 2.01 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.

## 2.02 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.

## 2.03 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.
   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.
   6. Internal and external galvanized steel for exterior pipes, 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. 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 **and** 10 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, red 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.

## 2.04 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, Nitrogen generator and 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 26. Valve externally resettable and internal components replaceable without removing valve. Victaulic Co. Series 768N or approved equal.

## 2.05 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.

## 2.06 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 and Dry Pipe Alarm Valve): Pressure type. System Sensor or approved.

C. Low Air Pressure Supervisory Switch (Dry Pipe 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. Electric Alarm Bell: 120 V. Weatherproof with red enameled painted hood, back box, and pressure switch. System Sensor or approved.

## 2.07 BUILDING FIRE ALARM SYSTEM INTERFACE

A. Coordinate with work specified in Division 28.

## 2.08 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.

## 2.09 NITROGEN GENERATION SYSTEM

A. Potter IntelliGen Nitrogen Generator:
   1. Furnish and install a nitrogen generator system at the fire sprinkler riser room to service all dry zones as required by the system size and pressure requirement stipulated in the drawings and installed per manufacturer's instructions.
   2. The nitrogen generator shall have an air compressor that is sized appropriately for the application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13.
   3. The nitrogen generator shall provide a minimum of 98% purity nitrogen to the dry pipe fire sprinkler system.
   4. The nitrogen generator shall be equipped with a filtration system to remove residual water and all hydrocarbons form the air stream.

5. The nitrogen generator shall have a nitrogen control panel capable of monitoring compressor runtimes, system pressure, and operational mode locally and over the internet.
6. The nitrogen generator shall have a leak detection system capable of determining if significant leaks develop within the sprinkler piping, nitrogen generator system or air compressor.
7. The nitrogen generator systems shall have the ability to automatically switch between air bypass mode and nitrogen generating mode based on the demands of the sprinkler system.
8. The nitrogen generator shall have an air storage tank and nitrogen storage tank air that confirm to ASME standard for pressure vessel.
9. Manufacturers: Potter Electric Signal Co., Series NGP, or approved substitute.

B. Nitrogen Purge Valve:
1. Furnish and install a nitrogen purge valve at the furthest point from the fire sprinkler riser for each fire sprinkler riser.
2. The nitrogen purge valve be supplied with a restricted orifice which size is determined by the total system pressure requirements.
3. The nitrogen purge valve shall have a nitrogen sensor that can shut off the purge valve after 98% nitrogen has been achieved throughout the fire sprinkler system.
4. The nitrogen purge valve shall monitor the nitrogen level in the Fire Protection System periodically.
5. The nitrogen purge valve shall have a BMS alarm relay to indicate trouble if nitrogen purity drops below desired purity.
6. The nitrogen purge valve shall be able to be networked with other purge valves.
7. The nitrogen purge valve shall be closed during hydrostatic and air pressure testing of the fire sprinkler system and then placed in the open position for the commissioning, treatment and operation of the system.
8. Manufacturers: Potter Electric Signal Co., Potter InteliPurge INS-PV, or approved substitute.

C. Air Maintenance Device:
1. Furnish and install an Air Maintenance Device for dry fire sprinkler system.
2. Air Maintenance Device shall be equipped with an adjustable pressure regulator that is capable of setting the required pressure for the fire sprinkler system.
3. The Air Maintenance Device shall be listed or approved for fire sprinkler application.
4. The Air Maintenance Device shall be installed per manufacturer's specifications.
5. Manufacturers: Potter Electric Signal, Co. Model AMD-1, or approved substitute. The air maintenance device shall be installed per the manufacturer's specifications.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

## 3.03 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.

## 3.04 EARTHWORK

A. Comply with requirements in Section 230510.

## 3.05 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 electric alarm bell on exterior wall of building. Obtain A/E approval of location.

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

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

R. 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.

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

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

## 3.06 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, including post indicator valves outside the building at the street.

## 3.07 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.

## 3.08 CORROSION PRODUCTS/SYSTEM COMMISSIONING PROTOCOL

A. Dry Pipe System:
   1. The fire sprinkler contractor shall confirm the operation of system air compressor and connect air compressor and nitrogen generator to the fire protection system.
   2. The fire sprinkler contractor shall determine the operating pressure range for the dry/preaction fire protection system and set the system air maintenance device for each fire protection system.
   3. The fire sprinkler contractor shall document the twenty-four (24) hour leak rate, in psig/hour, of each fire protection system and provide documentation as part of the As-Built document submittal.
   4. The fire sprinkler contractor shall provide all of the inerting vents at the locations shown on the approved shop drawings. The isolation ball valve of each device shall be closed during hydrostatic and/or air pressure testing of the fire protection system and then placed in the open position for the commissioning and operation of the system.
   5. The fire sprinkler contractor shall confirm the condensate water discharge from the air compressor drain and the nitrogen generator drain are piped to a floor drain or building exterior per local requirements.
   6. The fire sprinkler contractor shall confirm the In-Line Corrosion Detector is installed in the locations shown on the approved shop drawings and the pressure switch has been wired to the specified monitoring system.
   7. The fire sprinkler contractor shall install the fixed gas analyzer(s) at the locations as shown on the approved shop drawings. The fire sprinkler contractor shall confirm that the fixed gas analyzer(s) has been connected to the fire alarm control panel/BMS as shown on the approved shop drawings and that all connections have been made as specified and as indicated in the manufacturer’s installation instructions.
   8. The fire sprinkler contractor shall coordinate with the nitrogen generator manufacturer to schedule the on-site commissioning package at a time that has been coordinated with the General Contractor, Owner and Owner’s Representative.

## 3.09 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.

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.

## 3.10 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.

## 3.11 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.

### 3.12 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 SPRINKLER HEADS SCHEDULE

| Area/Ceiling | Head Type | Head Finish | Escutcheon Finish |
|---|---|---|---|
| Suspended or Hard Ceiling | Semi-Recessed | Satin Chrome | Satin Chrome |
| Areas without Suspended or Hard Ceilings | Upright | Satin Chrome | |
| Where Required | Sidewall | Satin Chrome | Satin Chrome |
| Subject to Freezing and not Connected to Dry Pipe System | Dry Recessed Pendent or Dry Recessed Sidewall | Satin Chrome | Satin Chrome |
| Detention areas identified on the drawings | Institutional anti ligature | Satin Chrome | Satin Chrome |

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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 230548 Vibration Isolation
7. Section 230550 Seismic Control
8. Section 230593 Testing, Adjusting, and Balancing
9. Section 230700 Mechanical Insulation
10. Section 230800 Mechanical Systems Commissioning
11. Section 230810 Systems Training
12. Section 230820 Systems Operations and Maintenance Manuals
13. Section 232116 Piping Specialties

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes modifications to the existing systems and domestic water piping for potable system 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.

### 1.02 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 D 2846, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
29. ASTM D 2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride( (PVC) Pipe and Fittings.
30. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
31. ASTM F 402, Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
32. ASTM F 438, Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
33. ASTM F 439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
34. ASTM F 441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
35. ASTM F 493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
36. ASTM F 876, Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
37. ASTM F 877, Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.
38. ASTM F 1545, Standard Specification for Plastic-Lined Ferrous Pipe, Fittings, and Flanges.
39. ASTM F 1960, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) Tubing.
40. ASTM F 2080, Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethene (PEX) Pipe and SDR 9 Polyethylene of Raised Temperature (PE-RT) Pipe.
41. AWS A5.8, Specification for Brazing Filler Metal.
42. AWWA C 104/A 21.4, Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water.
43. AWWA C 110/A 21.10, Standard for Ductile-Iron and Gray Fittings for Water.
44. AWWA C 111/A 21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
45. AWWA C 151/A 21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
46. AWWA C 153/A21.53, Standard for Ductile-Iron Pipe Compact Fittings for Water Service.
47. AWWA C651, Disinfecting Water Mains.
48. AWWA C652, Disinfection of Water Storage Facilities.
49. AWWA C700, Standard for Cold-Water Meters – Displacement Type, Bronze Case.
50. AWWA C701, Standard for Cold-Water Meters – Turbine Type, for Customer Service.
51. AWWA C702, Standard for Cold-Water Meters – Compound Type.
52. NFPA 13, Standard for the Installation of Sprinkler Systems.
53. NFPA 99, Standard for Health Care Facilities.
54. NSF 14, Plastic Piping System Components and Related Materials.
55. NSF 61, Drinking Water Systems Components – Health Effects.
56. NSF 372, Drinking Water Systems Components – Lead Content.
57. 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.

## 1.03 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. Ductile iron.
   3. Dielectric unions.
   4. Backflow preventers.
   5. Y-type strainers
   6. Basket strainers.
   7. Trap primers.
   8. Water hammer arresters.
   9. 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.
   2. Submit completed copy of reports and certificates and include copy in the Operations and Maintenance Manual.

## 1.04 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

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

## PART 2 PRODUCTS

### 2.01 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.

### 2.02 MANUFACTURERS

A. Copper Tubing: Cerro, Mueller, 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.

D. Origin: Items shall be manufactured in the United States.

### 2.03 COPPER TUBING

A. General: Copper tubing only. Sweat, press fittings, flanged, or grooved 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. 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.

E. Grooved Joint Couplings and Fittings:
   1. Suitable for Types K and L copper tubing. Sizes 2 through 8 inch.
   2. Compatible copper 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 with copper color code, 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.

F. Copper Press Fitting Couplings and Fittings:
   1. Suitable for Types K and L hard drawn copper tubing for sizes 1/2 through 4 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 Aalberts Industries ApolloPress®. 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.

## 2.04 DUCTILE IRON

A. 3 Inch and Larger, Outside Building (Buried) and Underground, Inside Building: Cement-lined. Joints with gaskets and restraining rod ties. AWWA C 104, AWWA C 110, AWWA C 111, AWWA C 151, and AWWA C 153.

## 2.05 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.

## 2.06 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. 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

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

D. Atmospheric Vacuum Breaker (AVB): ASSE 1001, 125 psig working pressure, brass body, full size orifice. Chrome plated where located in finished spaces.

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. Intermediate Atmospheric Vent Type (VDC): ASSE 1012 or ASSE 1022 depending upon application, suitable for continuous pressure application. Include inlet screen and

2 independent check valves with intermediate atmospheric vent. Chrome plated where located in finished spaces.

G. Manufacturers: As listed in “Backflow Prevention Assemblies Approved for Installation in Washington State.”

## 2.07 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. Grooved ends, 2 Inch and Larger: Ductile iron body.
4. FDA approved epoxy coating on interior and exterior surfaces.
5. Manufacturers: Armstrong Fluid Technology, Watts®, Crane, Hoffman Specialty®, Victaulic Co., Metraflex, Spirax Sarco, Nibco, or approved.

## 2.08 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.

## 2.09 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. 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.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

### 3.03 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.

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

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

G. Install piping to allow application of insulation.

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

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

J. Install isolation valves specified in Section 221120 and drain existing piping to accommodate installation of new Work.

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 hot water recirculating systems at branch connections to mains.

O. 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.

P. Install non-potable water signage.

## 3.05 SOLDERED JOINTS

A. Comply with applicable provisions of ASTM B 828 or “Copper Tube Handbook” by CDA for soldered 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, remove stems and washers of valves.

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

### 3.06 GROOVED JOINTS

A. Cut or roll grooves in ends of pipe based on pipe and couplings manufacturer's written instructions for pipe wall thickness.

B. Assemble joints with coupling and gasket, lubricant, and bolts.

C. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

D. Install new gaskets when existing couplings are disassembled.

### 3.07 COPPER PRESS FITTING COUPLINGS

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

### 3.08 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.

### 3.09 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.

### 3.10 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.

B. Install supplies, stops, pressure reducing valves, drains, traps, and similar devices as required between kitchen plumbing fixtures, faucets and equipment, and rough-in plumbing as required for a complete and operational installation. Install faucets, drains and accessories furnished by Division 11. Refer to Division 11 and kitchen drawings for additional requirements.

### 3.11 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.

## 3.12 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

## 3.13 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.

## 3.14 EXTERIOR PIPING INSTALLATION

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

## 3.15 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.

## 3.16 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

## 3.17 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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.

### 1.03 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. Solenoid valves.
   11. Vacuum relief valves.
   12. Thermostatic mixing valves.
   13. Valve operators.
   14. 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

### 2.01 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. Grooved Joint Valves: Use with grooved joint piping systems as specified in Section 221116 for sizes 2-1/2 inch and larger.

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

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

## 2.02 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.

## 2.03 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.

## 2.04 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.

## 2.05 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.

## 2.06 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.

## 2.07 BUTTERFLY VALVES

A. Comply with MSS SP-67.

B. 2-1/2 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 handwheel 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.

## 2.08 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.

## 2.09 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.

### 2.12 SOLENOID VALVES

A. General: Line size, brass, Buna-N seals and disc, general purpose enclosure, 24 V, 2 position, UL listed and labeled, normally closed. ASCO or approved.

### 2.13 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.

### 2.14 Thermostatic mixing valves, single lavatory/point of use

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 a single fixture 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 plastic temperature adjustment cap with vandal resistant locking screw.
   2. Adjustable high temperature limit stop set for 120 F.
   3. Union angle check vales on inlets.

D. Manufacturers: Leonard Valve Co. Model 170-LF, Powers LFG480, Acorn Engineering Co. Model ST70, or approved.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

## 3.03 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.

## 3.04 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.

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. Grooved Joint Valves: Use only for grooved joint piping systems specified in Section 221116.

L. Copper Press Fitting Valves: Use only for copper press fitting piping systems specified in Section 221116.

M. Include low voltage wiring in conduit for solenoid valves.

N. 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.

### 3.05 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

### 3.06 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
14. ASTM A 74, Standard Specification for Cast Iron Soil Pipe and Fittings.
15. ASTM A 106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
16. ASTM A 615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
17. ASTM A 888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
18. ASTM A 1064, Standard Specification for Carbon-Steel Welded Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
19. ASTM B 306, Standard Specification for Copper Drainage Tube (DWV).
20. ASTM C 564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
21. ASTM C 890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
22. ASTM C 1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
23. ASTM C 1540, Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Sewer Pipe and Fittings.

24. AWWA C 110/A 21.10, Standard for Ductile-Iron and Gray - Iron Fittings.
25. AWWA C 111/A 21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
26. AWWA C 151/A 21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
27. AWWA C 153/A21.53, Standard for Ductile-Iron Pipe Compact Fittings for Water Service.
28. CISPI 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
29. 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.
30. CSA B 481, Grease Interceptors.
31. 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.
32. IAPMO Z1001, Prefabricated Gravity Grease Interceptors.
33. IGC 237, IAPMO Guide Criteria for High Pressure Stainless Steel Shielded Couplings for Use with Hubless Cast Iron Soil Pipe and Fittings.

### 1.03 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.
   8. Blank copy of start-up and test report form.

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

### 1.04 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

### 2.01 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.

## 2.02 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.

## 2.03 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
         2) Heavy Duty Couplings for Above Ground 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. Clamp-All HI TORQ 80, Anaco-Husky SD 4000.
      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.
   4. Ductile Iron:
      a. Pipe: Mechanical joint, AWWA C151, with bell and spigot end.
      b. Fittings: Ductile or gray iron standard pattern, AWWA C110, or ductile iron compact pattern, AWWA C153.
      c. Glands, Gaskets, Tie Rods, and Bolts: Ductile or gray iron glands, rubber gaskets and steel tie rods and bolts, AWWA C111.

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.

D. Indirect Drain (Condensate) Piping: Copper.

## 2.04 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 recess, taper thread bronze plug. Verify floor finish with room finish schedule indicated on architectural drawings. Jay R. Smith Figure 4163S.

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.

## 2.05 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.

## 2.06 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, bottom outlet, 5 inch adjustable square 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, bottom outlet, 7 inch adjustable square nickel bronze strainer, sediment bucket, and vandal proof screws. Jay R. Smith Figure 2005.

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

### 2.07 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 minimum 16 gage Type 304 stainless steel receptor, no hub, dome bottom strainer, wide top flange,. Jay R. Smith Figure 3003.

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

### 2.08 ROOF DRAINS

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

B. RD-1, Roof Drain: 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: Cast bronze body, wall flange with pre-drilled counter-sunk mounting holes, and bird screen. Jay R. Smith Figure 1770.

### 2.09 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.

E. Valves: Comply with requirements in Section 221120.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

## 3.03 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.

## 3.04 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.

## 3.05 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 and as indicated on the drawings.

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

E. Demonstrate removal of cleanout covers.

## 3.06 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. Install flashings and flashing sleeves to be weatherproof. Install flanges in roofing materials to form watertight connection.

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.

## 3.07 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.

## 3.08 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. For installation where pressure testing was performed on multiple Sections of pipes, retest once all waste and vent piping has been installed.

## 3.09 START-UP SERVICES

A. Equipment manufacturer's authorized representative shall perform start-up services of automatic removal type grease interceptors 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.

## 3.10 PLUMBING 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.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes 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.

### 1.02 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 plumbing equipment.
   2. ASME BPVC, Boiler Pressure and Vessel Code, Section VIII, Division 01, Rules for Construction of Pressure Vessels.
   3. NSF 61, Drinking Water System Components - Health Effects.
   4. NSF 372, Drinking Water Systems Componentlus – 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.

### 1.03 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. Expansion tanks.
   2. 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.

## PART 2 PRODUCTS

### 2.01 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 with a silver-ion based antimicrobial compound.

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

### 2.02 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

### 3.05 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**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes plumbing fixtures and fittings, 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.

### 1.02 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. ANSI/SEA Z385.1, American National Standard for Emergency Eyewash and Shower Equipment.
3. ASSE 1011, Performance Requirements for Hose Connection Vacuum Breakers.
4. ASSE 1016, Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations.
5. ASSE 1019, Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
6. ASSE 1052, Performance Requirements for Hose Connection Backflow Preventers.
7. ASTMC 1822, Standard Specifications for Insulating Conversion Accessible Lavatory Piping.
8. ICC A117.1, Accessible and Usable Buildings and Facilities.
9. NSF 61, Drinking Water System Components – Health Effects.
10. NSF 372, Drinking Water Systems Components – Lead Content.
11. 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 the requirements of NSF 61 1nd 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.

### 1.03 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 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.

### 1.04 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.

### 1.05 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

### 2.01 MANUFACTURERS

A. Water Closets and Urinals: Kohler Co., American Standard, , Zurn Wilkins, Sloan Valve Company, Acorn Engineering Company® or approved.

B. Lavatories: Kohler Co., American Standard, , Acorn Engineering Company®, Bradley Corp., Zurn, Sloan Valve Company, or approved.

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

D. Service (Mop) Sink: Fiat Products, Kohler Co., Acorn Engineering Company®, or approved.

E. Shower Fittings: Symmons, Acorn Engineering Company®, Bradley Corp., Fiat Products, or approved.

F. Shower Heads/Faucets: Symmons, Acorn Engineering Company®, Bradley Corp., or approved.

G. Drinking Fountains and Electric Water Coolers: Elkay Mfg. Co., Haws Corporation, Halsey Taylor, Oasis International, Acorn Engineering 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: American Standard, Kohler Co., Delta Faucet Co., Elkay Mfg. Co., Just Manufacturing, Moen Commercial Div, Grohe, Chicago Faucets Co., Speakman Company, Leonard Valve Co., or approved.

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 Co., 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.

**2.02 PLUMBING FIXTURE 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. BrassCraft KT series, loose key angle pattern, quarter turn with lock shield, brass construction with polished chrome plated finish.

D. Rigid Risers: Chrome plated copper tubing with polished finish, 1/2 inch outside diameter.

E. Flexible Risers: Stainless steel braided reinforced polymer tube rated for use in potable water system as flexible water connection in accordance with ASME A112.18.6, 1/2 inch outside diameter.

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

G. Lavatory Strainer and Tail Pieces: McGuire 155 Series, or approved stainless steel brass fitting with perforated grid strainer and 17ga seamless brass tailpiece.

H. Sink Grid Strainer and Tail Pieces: McGuire 152 Series or approved, stainless steel brass fitting with perforated grid strainer and 17ga seamless brass tailpiece.

I. Sink Basket Strainer and Tail Pieces: McGuire 151 Series or approved, stainless steel brass fitting with perforated grid strainer and 17ga seamless brass tailpiece.

J. P-Traps: McGuire 8900 Series or approved, cast brass chrome plated body, 17 gage seamless chrome plated trap arm.

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

L. Trap Primers: Provide for floor receptors.

M. Exposed Supplies: Provide escutcheon, stop valve, and vertical rigid risers as specified in this Section.

N. Concealed Supplies: Provide escutcheon, stop valve, and vertical flexible risers as specified in this Section.

O. 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.

## 2.03 WATER CLOSETS

A. WC-1 Water Closet:
   1. Description: Kohler Kingston Model K-4325, wall mount, flush valve (top spud), siphon jet, white vitreous china with elongated bowl.
   2. Components:
      a. Flush Valve: Sloan Royal Model 111-SMO-1.28, battery powered, sensor operated, chrome plated, 1-1/2 inch top spud for wall hung fixtures, 1.28 gallon per flush. Include batteries.
      b. Seat: Church Model 1900SSC, self-sustaining check hinge with stainless post, no cover, open front.

B. WC-2 Lav-Toilet Comby with Lavatory Multi-Sided Bowl:
   1. Description: Acorn Penal-Ware 1415 Series, Left or Right offset as indicated on the drawings, Fixture shall be fabricated of type 304 stainless steel, seamless welded and exposed surfaces to have a satin finish, off floor wall mounted, with penal bubbler, hot and cold metering pneumatic valves, toilet designed for 1.28 gallon flush.
   2. Components:
      a. Flush Valve: Acorn manual flush valve, 1.28 GPF.
      b. Lavatory waste to be combined with toilet waste in the fixture. Lavatory to have built in overflow

C. WC-3 Lav-Toilet Comby ADA, Ligature Resistant
   1. Description: Acorn Secure-Care ligature resistant LR1449 Series, Left or Right offset as indicated on the drawings, Fixture shall be fabricated of 14 gauge, type 304 stainless steel, seamless welded and exposed surfaces to have a satin finish, floor mounted with wall discharge from WC and Lav, penal bubbler, hot and cold metering pneumatic valves, toilet designed for 1.28 gallon flush.
   2. Components:
      a. Flush Valve: Acorn manual flush valve, 1.28 GPF.

## 2.04 LAVATORIES

A. LV-1 Lavatory (ADA Compliant):
   1. Description: American Standard Lucerne Model 0356.421, wall hung, 20 inch by 18 inch, white vitreous china, overflow, back and side splash shields, single hole for faucet, concealed arm supports. Refer to architectural drawings for mounting height.
   2. Components:
      a. Faucet: Chicago Faucets Model 116.961.AB.1, HyTronic electronic faucet with dual beam sensor, single hole, deck mounted, 0.5 GPM non aerating spray, concealed mixing valve, Self-Sustaining Power System water turbine generates the necessary power, with .multiple field adjustable modes and ranges.
      b. Trim: Provide drain, tailpiece, P-trap, thermostatic mixing valve, and exposed supplies as specified in this Section.

## 2.05 SINKS

A. KS-1 Sink Double Bowl
   1. Description: Just Stylist Model DL-2143-A-GR, rectangular, double bowl, 21 inch front to back by 43 inch wide by 7-1/2 inch deep, each bowl 16 inch by 19 inch, 18 gage, Type 304 stainless steel, self-rimming, stainless steel mounting channel, polished finish, sound deadened, 8 inch centers.

2. Components:
    a. Faucet: Chicago Faucets Model 201-RSL9E3VPXKABCP, chrome plated, deck mounted mixing faucet, 9-1/5 inch restricted swing L type spout, ceramic cartridges, vandal proof aerator, 2-3/8 inch vandal proof lever handles, 8 inch centers.
    b. P-trap: McGuire Model 8903, 1-1/2 inch tailpiece to 2 inch waste connection, with Model 111C continuous waste, chrome plated, cleanout.
    c. Drain and Tailpiece: McGuire Model 151, chrome plated, basket strainer.

**2.06 Service (mop) sinks**

A. MS-1 Service (Mop) Sinks:
    1. Description: Fiat Model MSB- 3624,.corner type, floor mount, 36 inch long by 24 inch wide by 10 inch deep, molded stone with 1 inch wide shoulders.
    2. Components:
        a. Faucet: Chicago Faucets Model 897-CCP, with 2 offset inlet supply arms and 2 inlet adapters, wall mounted, manual mixing type with integral stops and check valves, 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. Strainer: Fiat 1453-BB, flat stainless steel.
        e. Vinyl Bumper Guard: Fiat E-77-AA.
        f. Silicone Sealant: Fiat 833-AA.

**2.07 SHOWERS**

A. SWR-1, Shower Trim:
    1. Description: Symmons Origins Model 9605-PLR-TRM, Temptrol Pressure Balancing Shower Valve and Symmons Dual Outlet Diverter valve ordered separately. Options to be included are 1.5 GPM flow restrictor, single mode shower head, single hand mode shower unit with ADA slide bar, with quick disconnect fitting for handheld ADA shower head

B. SWR-2 Detention Shower, Ligature Resistant:
    1. Acorn Penal-Ware LR1741 Series, Wall Shower, fabricated from 14 gauge, type 304 stainless steel and shall have a satin finish. Trim shall be stainless steel or chrome plated brass. Shower valve shall be air controlled hot & cold mixing and metering, ligature resistant Acorn model SV-16.

C. SWR-3 Detention Shower, :ADA, Ligature Resistant
    1. Acorn Penal-Ware LR1741 ADA Series, Wall Shower, fabricated from 14 gauge, type 304 stainless steel and shall have a satin finish. Trim shall be stainless steel or chrome plated brass. Shower valve shall be air controlled hot & cold mixing and metering, ligature resistant Acorn model SV-16.

**2.08 ELECTRIC WATER COOLER and BOTTLE FILLER**

A. EWC-1 Electric Water Cooler and Bottle filler, (ADA Compliant):
    1. Description: Elkay Model LVRC8WSK, self-contained, wall mount, surface mounted, fully assembled.

2. Construction: 16 gage Type 304 stainless steel basin, top, sides, and removable louvered ventilating front grill, polished satin finish, integral drain grid, polished chrome plated vandal resistant bubbler head, front push button operated stainless steel valve with in-line flow regulator, wall mounting box.
3. Refrigeration System: Hermetically sealed, reciprocating type compressor operating with R-134a refrigerant to produce 8.0 gph of 50 F drinking water at 90 F room temperature and 80 F inlet water temperature, pre-cooler, fan cooled condenser.
4. Electronic bottle filler button with mechanical front bubbler button activation.
5. Components:
   a. Water supply in-line filter.
   b. Trim: Provide p-trap and concealed supply as specified in this Section.

## 2.09 HOSE BIBBS AND WALL HYDRANTS

A. HB-1 Exterior Wall Hydrant, Concealed:
   1. Description: Woodford Model B65, recessed, non-freeze wall hydrant, brass valve body with hose end ASSE 1011 anti-siphon vacuum breaker, automatic draining, loose key, wall clamp, 3/4 inch inlet within chrome box with door assembly and loose key lock. Stem length to suit wall thickness.

B. HB-2 Interior Hose Bibb, Exposed:
   1. Description: Chicago Faucets Model 387-CP, exposed, polished chrome brass body with hose end, loose key, 3/4 inch inlet and outlet. Include hose end anti-siphon vacuum breaker.

## 2.10 SERVICE OUTLETS

A. SB-1 Refrigerator Water Service Box:
   1. Description: Guy Gray Model BIM875, recessed 20 gage galvanized steel wall box with 1/2 inch inlet and 1/4 inch angle supply valve, 20 gage galvanized steel cover.

B. WB-1 Clothes Washer Service Outlet:
   1. Description: Jones Stephens Corp. Model B05-922, white box, ball valves with lever handle and water hammer arresters, center drain.

## 2.11 GARBAGE DISPOSAL

A. GB-1 Garbage Disposal
   1. InSinkErator Model 444, continuous feed, stainless steel grinding elements and stopper, 3/4 HP. Include remote wall switch.

## 2.12 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.

### 2.13 THERMOSTATIC MIXING VALVES, SINGLE

A. Comply with requirements in Section 221120.

### 2.14 WALL AND FLOOR SEALANT

A. Manufacturer and Type: Color to match fixture. General Electric No. 1200 Silicone Building Sealant, Dow Corning No. 780 Construction Sealant, or approved.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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. 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 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.

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

K. 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.

L. Install shower, thermostatic mixing valve as specified in Section 221120, and shower head.

M. Install garbage disposal in outlet of each sink indicated to have garbage disposal. Install switch where indicated or in wall adjacent to sink if location is not indicated.

N. Install dishwasher air gap fitting at each sink indicated to have air-gap fitting. Install on countertop at sink. Connect inlet hose to dishwasher and outlet hose to disposer.

O. Install insta hot dispensers in countertop with spout over sink.

P. 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.

Q. Seal joints between fixtures and walls, floors, and counters with wall and floor sealant.

R. Trap Insulation for Accessible Fixtures: Install on exposed drainpipes, 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.

S. Install frost proof wall hydrants 36 inch above finished grade.

## 3.05 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.

## 3.06 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.

## 3.07 ADJUSTING

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

B. Operate and adjust disposers. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets, shower valves, and flush valves to produce proper flow and stream.

D. Adjust shower valve limit stops per manufacturer's installation instructions. Read hot water temperature after adjustment of limit stops to ensure maximum 110 F to 115 F water temperature.

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

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

## 3.08 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.

## 3.09 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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. 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.

C. National Air Duct Cleaners Association (NADCA):

1. ACR 2005, Assessment, Cleaning, & Restoration of HVAC Systems.
2. Understanding Microbial Contamination in HVAC Systems.
3. Introduction to HVAC System Cleaning Services.
4. NADCA Standard 05, Requirements for the Installation of Service Openings in HVAC Systems.

### 1.03 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. Section 211000including products and materials for first submittal and the Shop Drawings for second submittal.
    e. Long lead items.
    f. Site and underground work.
6. Clearly mark catalog pages, equipment, and model number to be used. Note required accessories.
7. Format:
    a. Assemble submittals in 3-ring binders. Use multiple binders if pages in a single binder would exceed 2-1/2 inch thickness. Separate binders for each category, such as Plumbing, Fire Suppression, and HVAC. Where one subject matter encompasses more than one binder, differentiate by volume numbers. Include indexed tabs for each binder.
    b. Include overall table of contents of items submitted, organized by specification section.
    c. Include heavy, tabbed divider sheet for each specification section, with specification section number and title on tab. Include table of contents for each specification section, including catalog numbers or drawing numbers if appropriate.
    d. Fold drawings to 8-1/2 inch size and bind as above (with reinforcing at punched holes) or place in clear plastic holder designed for 3 ring binders.
    e. Include contractor and manufacturer's representative contact information for each product.
8. 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. Submit one hard copy of product data.
4. 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. Section 211000 including products and materials for first submittal and the Shop Drawings for second submittal.

e. Long lead items.
f. Site and underground work.

5. 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.
6. 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. 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.

**1.04 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. Project Closeout and System Startup.
5. Punchlist.
6. Record Drawings.
7. Basic Materials and Methods.
8. Electrical Provisions.
9. Mechanical Demolition.
10. Mechanical Systems Commissioning.
11. Systems Training.
12. Systems Operations and Maintenance Manuals.
13. Fire Suppression Engineering and Shop Drawings.
14. Wet Pipe System, Labor.
15. Wet Pipe System, Material.
16. Dry Pipe System, Labor.
17. Dry Pipe System, Material.

18. Testing, Adjusting, and Balancing.
19. Mechanical Insulation, Labor.
20. Mechanical Insulation, Material.
21. Domestic Water, Labor.
22. Domestic Water, Material.
23. Lubrication System, Labor.
24. Lubrication System, Material.
25. Plumbing Valves, Labor.
26. Plumbing Valves, Material.
27. Plumbing Pumps Labor.
28. Plumbing Pumps, Material.
29. Soil, Waste, Vent, and Storm Drain Piping Systems, Labor.
30. Soil, Waste, Vent, and Storm Drain Piping Systems, Material.
31. Plumbing Equipment, Labor.
32. Plumbing Equipment, Material.
33. Plumbing Fixtures, Labor.
34. Plumbing Fixtures, Material.
35. Indoor Air Quality.
36. Piping Specialties, Labor.
37. Piping Specialties, Material.
38. Vibration Isolation, Labor.
39. Vibration Isolation, Material.
40. Seismic, Labor.
41. Seismic, Material.
42. Automatic Temperature Controls (ATC), Labor.
43. Automatic Temperature Controls (ATC), Material.
44. ATC Engineering and Shop Drawings.
45. ATC, Commissioning.
46. ATC, Owner Training.
47. Refrigerant Piping, Labor.
48. Refrigerant Piping, Material.
49. Air Distribution, Labor.
50. Air Distribution, Material.
51. Air Distribution Accessories, Labor.
52. Air Distribution Accessories, Material.
53. Air Distribution Equipment, Labor.
54. Air Distribution Equipment, Material.
55. Air Devices, Labor.
56. Air Devices, Material.
57. Packaged HVAC Equipment, Labor
58. Packaged HVAC Equipment, Material.

**1.05 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 |
| 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 |

## 1.06 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.

**1.07 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.

**1.08 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.

## 1.09 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 general contractor 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 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.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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.

### 1.02 QUALITY ASSURANCE

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

### 1.03 SUBMITTALS

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

B. Submit within 3weeks 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

### 3.01 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.

**3.02 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.

## 3.03 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.

## 3.04 FINAL ACCEPTANCE

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

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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.
   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.

### 1.03 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. Test Reports: As required in specific specification sections.

### 1.04 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

### 2.01 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.

### 2.02 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. Size bases 4 inch larger than equipment footprint in each direction unless noted otherwise on the Drawings.

## 2.03 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 and Firestopping in Fire and Smoke Rated Walls and Floors:
   1. Sleeves: Same material and thickness as used when firestopping material was tested and as listed in the UL Fire Resistive Directory.
   2. Firestopping: Material produced and installed as a system to resist spread of fire and passage of smoke and to maintain fire resistance of assembly. Material in accordance with ASTM E 814 and UL 1479. Johns Manville, Dow Corning, 3M™ Fire Protection Products, Nelson Firestop Products, STI-SpecSeal®, US Gypsum, or approved.

C. 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.

## 2.04 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.

## 2.05 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.

## 2.06 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.

## 2.07 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.

## 2.08 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 residents. 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.

### 2.09 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.

### 2.10 PAINTING

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

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

C. 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.

D. Pipe Curb Assembly: Consist of galvanized steel 12-inch high roof curb with cant strip, mitered corners, all welded construction, 1-1/2 inch thick rigid fiberglass insulation, 2 inch by 2 inch pressure treated wood nailer, and removable cover. The Pate Company Style CPBA Series cover with Style PCA-1 curb or approved.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

## 3.03 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.

## 3.04 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 Fire and Smoke Rated Walls and Floors: Install firestopping material in accordance with manufacturer's installation requirements.
   2. 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.

## 3.05 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.

## 3.06 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.

## 3.07 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.

## 3.08 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 pipelines of field.

## 3.09 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 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. Pumps
   2. Fans
   3. Packaged HVAC units
   4. Control panels
   5. Air handling units
   6. 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.

## 3.12 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.

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.

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.

## 3.13 PAINTING

A. Touch-up: Cover scratches, abrasions, and similar damages to equipment with factory finished surfaces using matching factory furnished paint.

B. Grilles, Registers and Diffusers: Paint inside surface of ducts, visible through grilles, registers, diffusers, and other openings with 1 coat of flat black paint to a point 2 feet from opening on straight ducts or around bend. Similarly, paint pipes and conduits visible through ceiling relief grilles.

## 3.14 REMOVAL AND REPLACEMENT OF EXISTING ACCESSIBLE CEILING PANELS

A. General: Remove and reinstall necessary panels in existing accessible ceilings to install mechanical work in areas where no architectural work is being performed. Where existing ceiling panels are damaged, replace with new to match existing. After ceiling removal and reinstallation is complete, ceiling system appearance shall match adjacent similar ceilings that have not been removed.

## 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 |
| 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 |

| PIPE SYSTEM | COLOR |
|---|---|
| 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 |

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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.

### 1.02 QUALITY ASSURANCE

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

### 1.03 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 after construction.
   2. Plan shall describe how 60 F to 65 F building temperature will be maintained, and supporting calculations achieving minimum of 14,000 cubic feet of outdoor air per square foot of floor area.
   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

### 3.01 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. Prior to Substantial Completion and as condition precedent thereto, operate HVAC air distribution systems for 14 consecutive days on 90 percent outside air at ambient temperatures throughout building for 16 consecutive hours during each 24 hour period. Do not commence flush out period until interior building construction components potentially emitting toxic pollutants are within building unless otherwise approved in writing by the Owner.

D. 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.

E. Maintain building temperature during flush out period at not less than 60 F to 65 F unless otherwise approved in writing by the Owner. Minimum of 14,000 cubic feet of outdoor air per square foot of floor area is required during flush out period.

F. Following final flush out, immediately replace filters, types as specified in Section 234100.

## 3.02 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.

## 3.03 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.

## 3.04 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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.

### 1.03 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

### 1.04 WARRANTY

A. Warrant motors controlled by variable frequency drives (VFDs) specified in Section 230915 for 3years after Substantial Completion date. Warranty shall cover materials, labor, and travel time. Make available replacement within 48 hours of initial notification.

## PART 2 PRODUCTS

### 2.01 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 SGRTM, 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: Minimum efficiencies as tabulated in current edition of the energy code in the state in which the work is performed as tested in accordance with IEEE 112, Test Method B.
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 ECMTM 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.

### 2.02 MOTOR STARTERS

A. General: Comply with requirements in Division 26 for factory installed starters. Field installed starters are specified in Division 26 work.

### 2.03 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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.

### 3.05 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.

### 3.06 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 |
| 9a. Duct Smoke Detectors: | E | M | E | E |
| 9b. Relays and Ancillary Devices Associated with HVAC Unit Shutdown by Duct Smoke Detectors: | E | E | E | E |
| 11. Variable Frequency Drives: | M | M | E | M |
| 12. Generator Fuel Control System: | M | M | E | M |
| 13. Section 230900 Control Panels: | M | M | M | M |

M = Division 22 and 23, Mechanical
E = Division 26, Electrical

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes selective demolition of existing fire suppression, plumbing, and HVAC work as indicated in the Contract Documents.

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.

### 1.02 QUALITY ASSURANCE

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

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Dust Control: Provide protective measures to minimize transfer of noise, dust, dirt, and refuse to adjacent areas of building. Such measure may include dusttight barriers, temporary walls, portable exhaust fans, vacuum systems, and temporary partitioning.

B. Extent: Keep areas of demolition as clean and orderly as physically possible. Do not allow demolition debris to accumulate. Gather debris and dispose daily. Broom or vacuum-clean work areas on daily basis.

C. Protection: Protect existing equipment, furnishing, and systems with protective coverings. Protect finished surfaces including floors, ceilings, and walls.

### 3.02 DAMAGES

A. Repairs: Promptly repair damage to existing surfaces, equipment, finishes, or adjacent facilities at no cost to the Owner and to the satisfaction of the A/E and the Owner.

### 3.03 CONTINUITY OF EXISTING UTILITY SERVICES

A. Comply with requirements in Section 230500.

### 3.04 DEMOLITION

A. General: Provide demolition work required in existing building for removal of existing fire suppression, plumbing, and HVAC equipment, ductwork, controls, and piping and for installation of new equipment, ductwork, controls, and piping. Relocate and modify existing equipment, controls, piping, and ductwork as required by general construction alterations and by installation of new equipment, ductwork, controls, and piping in existing building to achieve a complete and functioning installation.

B. Extent: Remove and dispose of existing materials indicated on the Drawings to be removed.

C. Termination of Demolition: Where existing piping and ductwork is removed, cut back to stack or riser. Provide isolation valve and cap piping and ductwork behind wall or below the floor. Remove unused branch piping and ductwork and piping in walls to be demolished, and cap remaining piping and ductwork.

D. Insulation: Replace damaged sections as specified for new systems where existing insulation is damaged due to cutting and connection to new systems.

E. Reuse: Do not reuse existing products unless indicated on the Drawings.

F. Materials to the Owner: Items tagged “SALVAGE TO OWNER”. Deliver items to the Owner’s Representative as indicated in the Contract Documents.

G. Materials to the Contractor: Materials other than those reserved by the Owner.

H. Existing Conditions: Comply with requirements in Division 01. Verify specific demolition work and operating conditions to be encountered from on-site review and coordination with the Owner. Maintain service to existing equipment and devices during new construction work as required by construction sequencing/scheduling provisions. In areas adjacent to new construction work, provide temporary services as necessary to meet these conditions. Protect active piping and wiring encountered. Notify the A/E of utilities encountered whose services are not known.

I. Repair of Damages to Underground Utilities: Exact location of existing underground utilities is not definitely known. Should any underground utilities be damaged in excavations, restore such utilities without additional cost to the Owner.

J. Drilling of Concrete: Drill openings through existing concrete with diamond tipped rotary core-drilling equipment or carbide tipped drills.

K. Saw-Cutting of Concrete: Saw cut through existing concrete with diamond tipped or carbide tipped saw blade.

L. Underground Ducts: Where shown on the Drawings to be abandoned, provide 2’-0” long foam insert in horizontal duct and fill remainder of duct with concrete to floor elevation. Refer to architectural drawings for floor finish.

## 3.05 DISPOSAL OF DEMOLISHED MATERIALS

A. Disposal: Remove debris, rubbish, and other materials resulting from demolition operations from building site unless reinstalled or delivered to the Owner as indicated in the Contract Documents. Transport and legally dispose of material off site.

B. Burning: Burning of removed materials is not permitted on project site.

## 3.06 CLEAN-UP AND REPAIR

A. Clean-Up: Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protection and leave interior areas clean.

B. Repair: Repair demolition performed in excess of that required at no additional cost to Owner. Return structures and surfaces to conditions existing prior to commencement of demolition work or as directed by the Owner.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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 piping, piping risers, and ductwork.
   3. Penetration isolation of pipes and ductwork through walls, floors, and ceilings.
   4. 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.

### 1.02 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.

### 1.03 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.
   7. Thrust restraints.

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.

### 1.04 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.

### 1.05 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 233100 – Air Distribution: Flexible connectors.

### 1.06 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

### 2.01 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.

### 2.02 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.

## 2.03 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.
   5. 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.

6. Manufacturer and Model: Mason Industries K or BMK Series.

C. Base B-5, Rigid Roof Curb:
1. Description: Prefabricated non-isolated seismic curb for mounting rooftop equipment, minimum 10 inch height above the finished roof insulation.
2. Construction:
a. Curb fabricated from structured steel channel or minimum 12 gage sheetmetal with factory installed wood nailer. Curb components field assembled with nuts, bolts, and self-tapping screws.
b. Cross bracing internal to curb.
c. Fabricate curb so that HVAC unit is installed level.
d. Manufacturer and Model: Mason Industries RRC Series.

## 2.04 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.

## 2.05 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.

## 2.06 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.

## 2.07 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.

### 2.08 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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.

## 3.05 DUCTWORK

A. Penetrations of Court Storage Room 217 Walls and roof and Acoustical Walls and Ceilings:
   1. Install sheet metal sleeves through walls and gypsum wallboard ceilings covering entire inside perimeter of oversized opening unless combination fire/smoke dampers are indicated in the Contract Documents. 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 unless combination fire/smoke dampers are indicated in the Contract Documents. 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. Duct Clearance: Install vibration-isolated ducts to allow minimum 2-inch gap between top of duct and underside of floor structure above.

C. Vibration Isolator Housing: Install as close as possible structure.

D. Ducts within Shafts: Install without contact with walls. Anchor to building structure at floor only.

## 3.06 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.

C. Piping 2 inch and Larger: Isolate within mechanical rooms or for first 50 feet from vibrating equipment, whichever is greater.

D. Vibration Isolator Housing: Install as close as possible to structure.

E. Risers: Isolate at point of contact with floor structure.

## 3.07 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.

## 3.08 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.

## 3.09 VIBRATION ISOLATION SCHEDULE

A. Vibration isolator designations are keyed to items specified in this section.

| EQUIPMENT | ISOLATOR | STATIC DEFLECTION (INCH) | BASE |
|---|---|---|---|
| FANS | | | |
| Centrifugal Fans, In-Line, Suspended | Type H-1 | 1.0 | |
| CONDENSING UNITS | Type IP-1 | -- | |
| ROOFTOP HVAC UNITS | Internal: Type S-2 | 1.0 | By Unit Mfr. Type B-5 |

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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.

### 1.03 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.

### 1.04 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. 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.
   2. 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.
   3. 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.

### 1.05 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

### 2.01 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.

### 2.02 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.

### 2.03 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.

### 2.04 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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.

### 3.05 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.

### 3.06 SEISMIC RESTRAINT SCHEDULE

A. Seismic restraint designations are keyed to items specified in this section.

| EQUIPMENT | SEISMIC RESTRAINT |
|---|---|
| FANS | |
| ROOFTOP HVAC UNITS | Rigid Roof Curb Type B-5 per Section 230548 |
| PIPING | |
| Suspend Piping Outside of Mechanical Rooms | IBC |
| Pipe Risers | IBC |
| DUCTS | |
| Suspended Ducts Outside of Mechanical Rooms | IBC |
| Floor-Mounted Ducts Inside Mechanical Rooms | IBC |

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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. NEEB, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
   4. 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. Note: In the following paragraph, include Hardin and Sons, GB Systems, and Penn Air Control only for projects less than 20,000 SF. Delete others per project requirements and previous experience as to their performance. List only Neudorfer and Hardin for projects for the North Thurston Public Schools and include “No substitutions.” List Neudorfer only if specifically requested by the Owner.
   5. TAB Subcontractors: National Indoor Air Care Corporation, Hardin & Sons, AIRTEST Co. Inc., American Air Measurement, Tac Systems, United Building and Energy Services.
   6. Obtain associated Product Data and Shop Drawings required to determine design--to--actual operating data (coil pressure drops, fan curves and similar data).

### 1.03 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. Fan curves.
c. Manufacturers’ start--up and test data.
d. Field start--up and test reports prepared by system and equipment installers.
e. List of test instruments and dates of last calibrated.
f. 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.

## 1.04 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.

### 1.05 COORDINATION

A. Attend and participate in 3field 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.

### 1.06 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

### 2.01 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, 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

### 3.01 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 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.

## 3.03 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.

## 3.04 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. 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.

E. Filters: After equipment and system check--out work has been completed, and prior to commencement of TAB work, perform the following:
   1. Remove air filters in air distribution equipment and systems and install new filters as specified in Section 234100.

F. 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.

G. 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.

H. Instrument Test Holes: Install at locations as directed by TAB subcontractor. Refer to Section 233100.

I. Cleaning: Clean equipment and devices after check--out and test run period prior to TAB work.

## 3.05 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. 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. Domestic hot water circulating systems.

C. 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.

D. 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. 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.

E. 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.

F. Static Pressure Setpoint for DOAS Systems:
   1. Adjust fan speeds and system static pressure setpoint, as necessary, to attain full 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. 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 CAV 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.

G. 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.

H. 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.
   3. Life safety systems will be rechecked in their entirety.

I. 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.

J. 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 overflow 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.

## 3.06 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.

## 3.07 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 3) commissioning meetings for coordination and support of commissioning process.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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 F 1249, Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
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.

## 1.03 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. Jacketing

## 1.04 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. Horizontal and vertical rainleaders and overflow rainleaders.
      c. Indirect condensate drain.
   3. "Cold HVAC Piping" includes the following:
      a. Refrigerant suction.
      b. Refrigerant liquid.
   4. "Hot Plumbing Piping" includes the following:
      a. Hot water and hot water circulating (all temperatures).
   5. "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.
   6. "Duct Not Within Conditioned Space" is duct for air that is located outside the building envelope or in unconditioned space.
   7. "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.
   8. "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.
   9. "Equipment" includes the following:
      a. Cold Equipment:
         1) Pipe unions.
         2) Strainers.
         3) Expansion joints.
         4) Roof drain and overflow roof drain bodies.
   10. "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.

### 1.05 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

### 2.01 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. Staples, Bands, and Wires: As recommended by insulation manufacturer for applications indicated.

H. 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. Childers CP-34, or Vimasco Corporation 749 or approved. Water vapor permeance per ASTM F 1249, 0.08 perms or less at 45 mil dry. White color. Foster® 30-65™ Vapor-Fas™ WB or approved.
   4. 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
   5. 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.
   6. Elastomeric Insulation Coating: Water based polyacrylate copolymer emulsion finish. Armaflex WB, K-Flex® 374, Aeroflex USA, Inc, Aerocoat™, or approved.

7. Elastomeric Insulation Adhesive: Foster® 85-75™Drion®, Armacell® 520, Aeroflex USA, Inc. Aeroseal,™ or approved.
8. 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). Childers CP-50A HV2 Chil-Seal, Foster® 30-36™ Sealfas®, Vimasco Corporation 713 and 714 or approved.
9. 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.

## 2.02 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 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.

## 2.03 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.

C. Insulate cold plumbing and cold HVAC piping at wall supports with insulated pipe hangers specified in Section 232116.

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 calcium silicate or cellular glass insulation, mitered sections of pipe insulation, or contoured calcium silicate or cellular insulation inserts. On below ambient piping, coat insulated elbows and fittings with vapor barrier coating and reinforcing mesh. Finish with metal 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.

### 2.04 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.

### 2.05 INSERTS BETWEEN PIPES AND PIPE HANGERS

### 2.06 Use insulated pipe hangers specified in Section 232116.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.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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.

## 3.05 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).
   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.

C. Ducts Specified to Have Soundlining: Refer to Section 233100. Need not be insulated unless additional insulation is required to meet thickness requirements of this section.

## 3.06 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. Extend surface finishes to protect raw edges, ends, and surfaces of insulation.

E. Install piping and duct insulation continuous through walls, ceilings, and floor openings and sleeves, except where firestop materials are required.

F. Install with joints tightly butted or adhered per manufacturer's requirements.

G. Install insulation to allow access to equipment for inspection and repairs.

H. Bevel and seal insulation around equipment nameplates and ASME labels.

I. 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.

## 3.07 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 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 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 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.

## 3.08 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.

## 3.09 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 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.
   4. Piping and ducts located outdoors.
   5. 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.

## 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 EXTENT OF PIPE INSULATION

A. Insulate piping in the Contract Documents per the schedule on the drawings.

## 3.13 EXTENT OF DUCT INSULATION

A. Insulate ductwork in the Contract Documents per the schedule on the drawings.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes Division 21, 22, and 23 responsibilities and participation in commissioning process to demonstrate compliance of mechanical systems in accordance with the Contract Documents.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, and Sections 230505, 230593, 230810, and 230820 apply to the Work in this section.

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards: Applicable energy code.

### 1.03 CONTRACTOR RESPONSIBILITIES FOR COMMISSIONING

A. General:
   1. Commissioning is the responsibility of Division 21, 22, and 23 subcontractors, their subcontractors, and their equipment suppliers.
   2. Division 21, 22, and 23 subcontractors are responsible to support the building commissioning process for systems, led by a certified commissioning professional as defined by the current WSEC, and shall be completed for the applicable mechanical, refrigeration, service water heating, and energy metering.
   3. Division 21, 22, and 23 subcontractors are responsible to provide support required for start-up, testing, and commissioning.
   4. Commissioning process requires that portions of the Work have been completed in a satisfactory and fully operational manner.
   5. Include commissioning status during construction phase to monitor progress.

B. Basic Commissioning:
   1. Where the certified commissioning professional is an employee of one of the registered design professionals of record or an employee or subcontractor of the project contractor, an In-House Commissioning Disclosure and Conflict Management Plan shall be submitted with the commissioning plan.
   2. Within 20 days after contract award to the Contractor, prepare preliminary schedule and Commissioning Plan for pipe and duct system testing, flushing and cleaning, equipment start-up, and testing, adjusting and balancing for verification by the A/E. Include the names, statement of qualifications, roles and responsibilities of each member of the commissioning team for each phase of the commissioning activity. Include schedule in master project construction schedule and update schedule as appropriate.
   3. Division 21, 22, and 23 subcontractors are responsible to provide support required for start-up, testing, and commissioning.
   4. Give minimum 48 hours prior notice to the A/E when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur. Be responsible to notify the Commissioning Authority and the A/E when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the A/E has obtained scheduling information needed to efficiently execute commissioning.

5. Schedule start-up and testing of equipment and systems.
6. Assist in testing, adjusting, and balancing. Allow sufficient time before commissioning commences so that testing, adjusting, and balancing can be accomplished and deficiencies corrected.
7. Operate equipment and systems for commissioning tests.
8. Assign qualified personnel for participation in commissioning functional performance tests, including seasonal testing required after initial commissioning.
9. Complete pre-functional test checklists included in Appendix A at end of this section and submit to the A/E to assure that equipment and systems are fully operational and ready for functional testing.
10. Assist in functional performance testing to verify equipment and system performance.
11. Furnish equipment, materials, and labor necessary to correct deficiencies found during commissioning process which fulfill contract and warranty requirements.
12. Prepare preliminary commissioning report for review and approval by the A/E.
13. Prepare operations and maintenance information and Record Drawings. Comply with requirements in Section 230820.
14. Assist in developing system operation descriptions.
15. Schedule and arrange for training for systems specified.
16. Coordinate with equipment manufacturers to determine specific requirements to maintain warranties.
17. Correct deficiencies and submit signed documentation demonstrating to the A/E that deficiencies have been corrected.
18. Prepare final commissioning report for review and approval by the A/E.

## 1.04 SUBMITTALS

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

B. Commissioning Plan: Commissioning Plan shall be developed by a registered design professional or approved agency and shall include the following items:
   1. Narrative description of activities that will be accomplished during each phase of commissioning, including personnel intended to accomplish each activity.
   2. Roles and responsibilities of commissioning team members.
   3. Schedule of activities including systems testing and balancing, pre-functional testing, functional testing, and supporting documentation.
   4. List of specific equipment, appliances, and systems to be tested and description of tests to be performed.
   5. Functions to be tested.
   6. Conditions under which tests will be performed.
   7. Measureable criteria for performance.

C. Preliminary Commissioning Report: Preliminary report of commissioning test procedures and results shall be completed and certified by a registered design professional or approved agency and provided to the Owner and the A/E. Report shall be identified as “Preliminary Commissioning Report” and shall identify:
   1. Itemization of deficiencies found during testing required by this section that have not been corrected at time of report preparation.
   2. Deferred tests that cannot be performed at time of report preparation because of climatic conditions. Include anticipated date of completion.
   3. Climatic conditions required for performance of deferred tests.

4. Record of progress and completion of operator training.
5. The code official shall be permitted to require a copy of the preliminary commissioning report be available for review by the code official.

D. Final Commissioning Report: Report of test procedures and results identified as “Final Commissioning Report” shall be completed and certified by a registered design professional or approved agency and shall be delivered to the Owner and the A/E and shall include:
1. Results of functional performance tests.
2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.
4. Exception: Deferred tests which cannot be performed at time of report preparation due to climatic conditions.
5. Copies of all documentation shall be made available to the code official upon request.

## PART 2 PRODUCTS

### 2.01 TEST EQUIPMENT

A. Description: Test equipment as necessary for start-up and testing of mechanical equipment.

B. Proprietary Test Equipment:
1. For products in which proprietary test equipment is needed for functional performance testing, product manufacturer shall furnish test equipment, demonstrate its use to the A/E. Proprietary test equipment shall become property of the Owner upon completion of commissioning.
2. Identify proprietary test equipment required in test procedures submittals. Include separate list of equipment to be included in Operations and Maintenance Manuals.

## PART 3 EXECUTION

### 3.01 WORK PRIOR TO COMMISSIONING

A. Description:
1. Complete all phases of the Work so various systems can be started, tested, adjusted, balanced, and otherwise commissioned. Submit written notification to the Owner’s Representative and the A/E that the systems have been calibrated, tested, are operating properly, and are ready for commissioning at least 14 days prior to scheduled commissioning.
2. Division 21, 22, and 23 subcontractors have primary start-up responsibilities with obligations to complete systems, including sub-systems, so they are fully functional. This includes complete installation of equipment, materials, pipe, duct, wire, insulation, controls, and similar items per the Contract Documents and related directives, clarifications, and change orders.

B. Scheduling: Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to completion of systems and sub-systems subject to coordination with the A/E. Start of commissioning before system completion will not relieve subcontractor from completing those systems per construction schedule.

### 3.02 PARTICIPATION IN COMMISSIONING

A. Description:

1. Start up and test of systems by skilled technicians. Make these same technicians available to assist in completing commissioning program as it relates to each system and their technical specialty.
2. Coordinate work schedules, time required for testing, and similar conditions with the A/E. Ensure that qualified technicians are available and present during agreed upon schedules and for sufficient duration to complete necessary tests, adjustments, and problem resolutions.

B. System Problems and Discrepancies: These may require additional technician time, additional A/E time for redesign, and reconstruction of systems and system components. Make additional technician time available for subsequent commissioning periods until required system performance is obtained.

C. Qualifications of Technicians: The A/E has right to judge appropriateness and qualifications of technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to specific equipment involved, adequate documentation and tools to service/commission equipment, and attitude and willingness to work with the A/E to get the Work done.

D. Functional Performance Testing: Functional performance testing specified in applicable energy code shall be conducted. Written procedures which clearly describe individual systematic test procedures, excepted systems' response or acceptance criteria for each procedure, actual response or findings, and any pertinent discussion shall be followed. At minimum, testing shall affirm operation during actual or simulated winter and summer design conditions and during full outside air conditions.
   1. Equipment: Equipment functional performance testing shall demonstrate installation and operation of components, systems, and system-to-system interfacing relationships in accordance with the Contract Documents such that operation, function, and maintenance serviceability for each commissioned systems is confirmed. Testing shall include modes and sequence of operation, including under full-load, part-load and the following emergency conditions:
      a. Modes as described in sequence of operation.
      b. Redundant or automatic back-up mode.
      c. Performance of alarms.
      d. Mode of operation upon loss of power and restoration of power.
   2. Controls: Test HVAC control systems to document that control devices, components, equipment, and systems are calibrated, adjusted, and operate in accordance with the Contract Documents. Sequences of operation shall be functionally tested to document they operate in accordance with the Contract Documents.

## 3.03 WORK TO RESOLVE DEFICIENCIES

A. Description:
   1. In some systems, misadjustments, misapplied equipment, and deficient performance under varying loads will result in additional work being required to commission systems. Complete the Work under direction of the A/E with input from appropriate subcontractor and equipment supplier.
   2. Whereas all members will have input and opportunity to discuss the Work and resolve problems, the A/E will have final authority on necessary work to be done to achieve performance.

B. Timing:
   1. Complete corrective work to permit completion of commissioning process.

2. Experimentation to achieve system performance permitted. However, if the A/E deems experimentation work is ineffective or untimely as it relates to commissioning process, the A/E will notify the Owner indicating nature of problem, expected steps to be taken, and provide deadline for completion of activities.
3. If deadlines pass without resolution of the problems, the Owner reserves right to obtain supplementary services and equipment to resolve problems. Costs incurred to solve problems in an expeditious manner will be subcontractor's responsibility.

## 3.04 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, and similar activities are completed. Division 21, 22, and 23 subcontractors and suppliers shall include reasonable reserve to complete this Work as part of their standard contractual obligations.

## 3.05 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.
   1. Participate in training of the Owner's engineering and maintenance staff on each system and related components as required in Divisions 01, 21, 22, and 23 sections.
   2. Conduct training in classroom setting with system and component documentation and suitable classroom training aids.
   3. Conduct field training as necessary to facilitate instruction on specific equipment and systems.

## 3.06 SYSTEMS DOCUMENTATION

A. Drawings: Maintain as-built red-lines as required in Division 01 and Section 230500. Given size and complexity of project, red-line drawings prepared at completion of construction based on memory of construction personnel not acceptable. Continuous and regular red-lining of drawings to indicate actual constructed conditions is considered essential and mandatory.

B. Operations and Maintenance Data: Comply with requirements in Section 230820. Submit one copy of equipment technical literature, operation and maintenance literature, and shop drawings to the A/E as soon as they are available. This requirement is for review of documents prior to distribution of multiple copies for the Owner's final use.

C. Division 21, 22, and 23 subcontractors shall prepare applicable portions of Washington State Energy Code Commissioning Compliance Checklist to comply with requirements of WSEC commissioning requirements.

## PART 1 GENERAL

### 1.01 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.

### 1.02 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. Video record training sessions with emphasis of video subject and hands-on equipment operation. Following training sessions, deliver 2copies of CD/DVD to the Owner.

### 1.03 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.

### 1.04 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 3 hours.
   2. DIVISION 22:
      a. SECTION 221116 DOMESTIC WATER SYSTEM: Total of1 hours.
      b. SECTION 221300 SOIL, WASTE, VENT, AND STORM DRAIN SYSTEM: Total of 1 hours.
   3. DIVISION 23:
      a. SECTION 230800 MECHANICAL SYSTEMS COMMISSIONING: Total of 1 hours.
      b. SECTION 230900 AUTOMATIC TEMPERATURE CONTROLS: Total of 2 hours.
      c. SECTION 232300 REFRIGERANT PIPING: Total of 1 hours.
      d. SECTION 233100 AIR DISTRIBUTION: Total of1 hours.
      e. SECTION 233300 AIR DISTRIBUTION ACCESSORIES: Total of1 hours.

f. SECTION 233400 AIR DISTRIBUTION EQUIPMENT: Total of 1 hours.
g. SECTION 234100 FILTERS: Total of 1 hours.
h. SECTION 238100 PACKAGED HVAC EQUIPMENT: Total of 2 hours.

## PART 2 PRODUCTS

Not Used.

## PART 3 EXECUTION

### 3.01 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.
   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) 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.

**3.02 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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 CD/DVD to the Owner.

## 1.03 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.

## 1.04 TABLE OF CONTENTS

A. Warranty

B. Preventative Maintenance Schedule

C. Filter List

D. Belt List

E. Fuse List

F. Final TAB Report

G. DIVISION 21 - Fire Suppression:
   1. Grooved piping and couplings.
   2. Valves.
   3. Sprinkler heads.
   4. Alarm valve assemblies.
   5. Water flow detectors.
   6. Air compressors/Nitrogen generator.

H. DIVISION 22 - Plumbing:
   1. Fixtures.
   2. Flush valves.
   3. Faucets.
   4. Valves.
   5. Hose bibbs and wall hydrants.
   6. Meters.
   7. Backflow preventers.
   8. Trap primers.
   9. Pumps.

I. DIVISION 23 - HVAC:
   1. Air handling units.
   2. VRF Fan coil units.

3. Packaged HVAC equipment.
4. Pressure switches.
5. Fans.
6. Fire dampers, ceiling radiation dampers, smoke dampers, and combination fire/smoke dampers.
7. 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

### 2.01 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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.

### 1.03 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. Pipe escutcheons.

## PART 2 PRODUCTS

### 2.01 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.

### 2.02 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: Plain 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.

## 2.03 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.

## 2.04 PIPE SUPPORTS ON ROOF

A. Description: Adjustable height pipe support consisting of one-piece hot dipped galvanized steel support base and single or double piece of galvanized steel strut connected with stainless steel all thread. Rated for maximum load weight of 150 pounds per pipe stand. Height adjustable from 4 to maximum 12 inch from top of roof membrane.

B. Manufacturers: Miro Industries, Inc. Pillow Block Pipestand Base Strut Model, The Pate Company, Thybar Corporation, Erico CADDY® PYRAMID, Roof Top® Blox, or approved.

C. 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.

D. Manufacturers: KB Enterprises SNAPP ITZ for both hot and cold pipe applications or approved.

## 2.05 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.

## 2.06 THERMOMETERS

A. Description: Industrial grade, cast metal case, separable socket construction; non-toxic, colored organic spirit filled glass tube; 9-inch scale length. Range 0 F to 100 F with 1 F increments for chilled water piping and 50 F to 250 F with 2 F increments for heating water and condenser water piping.

B. Thermal Wells: Matched to thermometer stem. Brass, 3/4 inch NPT, extension neck length to extend 1 inch beyond the pipe insulation jacket. Well lengths shall cover a bulb insertion depth inside pipe across a minimum of 2/3 of pipe inside diameter.

C. Manufacturers: Weiss Instruments Inc., Ashcroft Inc., Palmer Wahl, Trerice, Weksler®, Marsh Instruments, Taylor Precision Products, Miljoco Corporation, or approved.

## 2.07 PRESSURE GAGES

A. Description: 4-1/2 inch size, stem mounting, cast metal case without back flange, cast metal threaded ring, phosphor bronze liquid filled bourdon tube, diaphragm seal, white face with black numerals, adjustable pointer. Plus or minus 1 percent accuracy over full scale range. Identify units of measurement by means of a factory-applied inscription on the faceplate of each gage such as pounds per square inch.

B. Needle (Gage) Valve: Brass needle valve, 600 psig WSP at 300 F, 1/4-inch NPT.

C. Appurtenances: 1/4-inch nipple, reducer, and snubber.

D. Pressure Ranges: Maximum gage pressure not greater than 150 percent nor less than 110 percent of the anticipated maximum pressure at point of installation. Select range so that normal operating point is near mid-scale of gage range. Gages 0 to 100 psig : 1 psig maximum pressure increment per gage mark. Gages 1 to 200 psig: 2 psig. Gages 1 to 300 psig: 5 psig.

E. Manufacturers: Weiss Instruments Inc., Lonergan, Weksler®, Marsh Instruments, Taylor Precision Products, AMETEK® U.S. Gauge, Ashcroft Inc., Trerice, Miljoco Corporation, or approved.

## 2.08 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.

## 2.09 SEISMIC FLEXIBLE LOOPS

A. Description: Flexible expansion loop specifically designed for seismic movement in 6 degrees of freedom simultaneously.

B. Design: Plus or minus 4 inch movement.

C. Construction:

1. Three equal length braided hose sections of bronze hose and bronze braid connecting four-90 degree elbows for attachment to copper tubing systems. Ends sweat or threaded for temperature up to 450 F.

2. Type 321 stainless steel hose and braid connecting, four– 90 degree elbows for attachment to steel or stainless steel pipe systems. Ends flanged, screwed, welded, or grooved for operating temperatures up to 850 F.
3. Designed for pressure testing to 1-1/2 times their maximum rated working pressure with minimum 4 to 1 (burst to working) safety factor. Factory tested using air-under-water or hydrostatic pressure. Assemblies for use in systems with compressed or flammable gases UL 536 listed and labeled. Assemblies for use in fire suppression systems FM approved. Include cable hanger assembly kit for sloped pipes installed in horizontal position and cable anchor kit.

D. Manufacturers: Flex-Hose Co., Inc. Tri-Flex Loop® 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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 insulated hot pipes 2 inch and larger and for all sizes of insulated cold pipes specified in Section 230700.

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.
   2. Support polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) pipes at maximum 4 foot spacing for straight runs.

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.

**3.05 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.

## 3.06 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. Pressure regulators.
   3. Solenoid valves.

## 3.07 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.

## 3.08 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.

## 3.09 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 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 anchors to direct movement axially into seismic flexible loop as required by manufacturer.

### 3.11 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.

### 3.12 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 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 |

### 3.14 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 |

| 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 |
| 2-1/2 | 11 | 14 | 9 | 13 |
| 3 | 12 | 15 | 10 | 14 |
| 4 | 14 | 17 | 12 | 16 |
| 6 | 17 | 21 | | |

**END OF SECTION**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
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.

## 1.03 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. Flexible ducts.
5. Duct soundlining, fiberglass.
6. Fasteners.
7. Hangers for sheet metal work.
8. Miscellaneous duct accessories.
9. 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. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

### 1.04 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

### 2.01 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. DOAS system 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.
   2. 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.
   3. DOAS Outside Air Ducts: Plus 2 inch w.g.
   4. Supply Ducts not Listed Above: 2 inch w.g.
   5. 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

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.

## 2.02 SHEET METAL WORK, MISCELLANEOUS

A. Exhaust Ducts Serving Locker Rooms, Showers, and Similar Wet Areas: Aluminum, ASTM B 209, same gage as specified in Article "Sheet Metal, General" in this section.

B. Clothes Dryer Vent Duct:
   1. Flexible Duct: Aluminum. UL listed and labeled. Foil flexible, plastic, or vinyl hose not acceptable.
   2. Rigid Duct: Type 304 stainless steel, ASTM A 480, minimum 24 gage with no fasteners protruding into duct.

## 2.03 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.

## 2.04 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.

## 2.05 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.

## 2.06 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.

## 2.07 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. 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.

## 2.08 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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, VRF Fan coil and ceiling cassette units 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 ducts within shafts without contact with walls.
14. Install ducts, unless otherwise indicated on the Drawings, vertically and horizontally and parallel and perpendicular to building lines.
15. 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.
16. Install return air and transfer air openings above ceilings with minimum 2’ - 0” clearance to obstructions.

B. Clothes Dryer Vent Duct: Install flexible duct between appliance connection and rigid duct. Install with stainless steel worm drive hose clamp on both ends. Eight foot maximum length, fully extended. Install male end of rigid duct in direction of airflow. Install cleanouts for vertical risers.

C. 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 equipment without flexible connectors in corridor ceiling spaces where fire rating is required.

D. Duct and Plenum Sealing: 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.
1. Duct Testing: Comply with requirements in Article “Pressure Testing for Leakage” in this section
2. 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.

## 3.05 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.

## 3.06 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 10feet from HVAC unit, Coordinate with requirements of Section 230700.
   2. Grille and diffuser boxes and boots.
   3. Transfer ducts.
   4. Return and exhaust air ducts for first 10 foot from grille except for those grilles serving showers and an additional 10 foot from the HVAC unit.

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.

## 3.07 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.

## 3.08 PRESSURE TESTING FOR LEAKAGE

A. Description: Test the DOAS systemsupply and returnducts including rectangular, round, and flat oval duct systems.

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 |

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.

## 3.09 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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 105, Standard for Smoke Door Assemblies and Other Opening Protectives.
12. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
13. SMACNA Fire, Smoke and Radiation Damper Installation Guide.
14. SMACNA HVAC Duct Construction Standards, Metal and Flexible (SMACNA), Third Edition, 2005.
15. UL 181, Factory-Made Air Ducts and Air Connectors.
16. UL 555, Fire Dampers.
17. UL 555C Ceiling Dampers.
18. UL 555S, Smoke Dampers.
19. UL 723, Test for Surface Burning Characteristics of Building Materials.
20. UL 1995, Heating and Cooling Equipment.
21. UL 1996, Electric Duct Heaters.
22. UL 1978, Standard for Grease Ducts.

### 1.03 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. Automatic balancing dampers.
   3. Fire dampers including installation instructions.
   4. Ceiling radiation dampers including installation instructions.
   5. Combination fire/smoke dampers including installation instructions.
   6. Access doors and frames.
   7. Clothes dryer vent components.
   8. Duct security bars.
   9. 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 new and existing 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. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

### 1.04 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 230900 – Automatic Temperature Controls: Motorized dampers and air terminal unit controllers and actuators.

B. PRE-INSTALLATION MEETING

C. 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

### 2.01 MATERIALS

A. Comply with SMACNA.

### 2.02 VOLUME DAMPERS AND QUADRANTS

A. General: Fabricate in accordance with SMACNA, same material as for duct construction.

B. 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.

C. Quadrants Where Ducts are Accessible:
   1. Description: Handle regulator set with hex nut and acorn nut. Full length shaft, sizes meeting SMACNA Standards for damper blade sizes. Include closed end cast alloy bearing and standoff bracket for ducts with external insulation, height to accommodate insulation thickness specified in Section 230700.
   2. Manufacturers: Duro Dyne Corp., Young Regulator Company, Ventfabrics, Inc., or approved.

D. Quadrants Where Ducts are Not Accessible:
   1. Description: Concealed style regulator set with hex nut, cast alloy corrosion resistive plated cover, couplings, and 90 degree angle drive die cast miter gear assembly for round or square damper rod. Cover prime painted.

E. Manufacturers: Duro Dyne Corp., Ventfabrics, Inc., Young Regulator Company, or approved. Remote Cable Control System for Quadrants Where Ducts are Not Accessible:
   1. Description: Cable system for remote operation of a volume damper consisting of Bowden 0.054 inch sheathed stainless steel control wire, rack and pinion gear drive, and control kit for flush ceiling mounting**,** control kit mounting bracket for installation on ceiling framework, behind grilles, or as required to accommodate ceiling conditions for various ceiling systems in the project.
   2. Manufacturer: Young Regulator Company Bowden Cable Controls or approved.

**2.03 AUTOMATIC BALANCING DAMPERS (CAV as identified on the drawings)**

A. Description: Circular volume flow controllers for constant and variable air volume systems with low airflow velocities, mechanical self-powered, without external power supply, suitable for supply or exhaust air. Ready-to-commission unit consists of the casing containing a damper blade with low-friction bearings, bellows, leaf spring, and a rotary knob to set the volume flow rate setpoint.

B. Construction:
   1. Inlet suitable for circular ducts to ANSI/SMACNA 006-2006 and EN 1506 or EN 13180.
   2. Casing air leakage to EN 1751, class C.
   3. Volume flow rate can be set using an external scale; no tools required
   4. Simple retrofit of an actuator is possible
   5. Correct operation even under unfavorable upstream or downstream conditions (1.5 D straight section required upstream)
   6. Any installation orientation
   7. Aerodynamic function testing of each unit on a special test rig prior to shipping
   8. Casing in galvanized sheet steel
   9. Damper blade and other parts made of metal or plastic to UL 94, V1; to DIN 4102, material classification B2
   10. Leaf spring made of stainless steel
   11. Polyurethane bellows

C. Technical data:
   1. Nominal sizes: 4 - 10 in
   2. Volume flow rate range: 13 - 775 CFM
   3. Volume flow rate control range: approx. 10 – 100 % of the nominal volume flow rate

4. Volume flow rate accuracy: approx. ± 10 % of the nominal volume flow rate
5. Minimum differential pressure: 0.12 in w.g. (30 Pa)
6. Maximum differential pressure: 2 in (500 Pa)

D. Manufacturer: Trox VFC, Aldes MR MAX, Young Regulator CVD or approved.

## 2.04 CEILING RADIATION DAMPERS

A. Description: Ceiling radiation dampers, each with frame sleeve for wall and floor installations. Comply with SMACNA. Include UL Fire Resistance Classified Ceiling Diffuser Radiation shields

B. Classification: UL 555C, NFPA 90A. UL listed and labeled for dynamic systems with airflow in either direction. Include label for 3 hour fire rating.

C. Type: Mill galvanized finish, metal, two-piece, single-thickness with fire-resistive thermal blanket, hinged in center, and held open with replaceable 165 F fusible link and spring stainless steel hinge mechanically attached to blades for horizontal installations.

D. Manufacturers: Ruskin Company, Air Balance, Inc., Nailor Industries, Inc., or Greenheck Fan Corp.

## 2.05 COMBINATION FIRE/SMOKE DAMPERS

A. Description: Combination fire/smoke dampers, each with frame, sleeve, airfoil blades, and actuator for wall, floor, and ceiling installations, 250 F. 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. Manufacturers: Ruskin Company Model FSD60, Air Balance, Inc., Nailor Industries, Inc., or Greenheck Fan Corp.

## 2.06 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.

## 2.07 CLOTHES DRYER VENT COMPONENTS

A. Dryer Vent Receptacle: 22 gage aluminized steel receptacle with top or bottom opening for connection between flexible and rigid ducts. Include furring strip for installation in 2 by 4 wall. Powder coated finish. UL listed and labeled for installation in 1 hour fire rated wall. In-O-Vate Technologies Inc. Dryerbox® Recessed Dryer Receptacle Model DB-480 (561-743-8696) or approved.

B. Dryer Lint Box: 24 gage galvanized steel construction with polycarbonate gasketed door with piano hinge and cam lock. Lint collector with interior angle support and handle. Four inch round connections on top and bottom. Columbia HVAC Products (1-877-620-82581) or approved.

## 2.08 SECURITY BARS

A. Description: Factory assembled all welded construction with sleeve for installation at duct penetrations through security walls, floors, and roofs.

B. Penetrations through Walls and Floors:
   1. Sleeve: 3/16 inch thick steel stitch welded along entire length of seams. Sleeve length to accommodate wall thickness.
   2. Vertical Bars: 3/4 inch diameter steel bars on maximum 6 inch centers.
   3. Horizontal Bars: 2 inch by 1/4 inch steel flat bars on maximum 8 inch centers.
   4. Intersection of Bars: Welded at each cross point.
   5. Frame: 1-1/2 inch by 1-1/2 inch by 1/8 inch angle, one factory skip welded in place and one shipped loose for field welding in place.

6. Finish: Factory baked acrylic point.

C. Penetrations through Roof:
   1. Round Bars: 3/4 inch diameter steel bars on maximum 6 inch centers, in general. Type 304 stainless steel for dishwasher exhaust duct, 1/2 inch diameter.
   2. Flat Bars: 2 inch by 1/4 inch steel flat bars on maximum 6 inch centers. Type 304 stainless steel for dishwasher exhaust duct.
   3. Intersection of Bars: Welded at each cross point.
   4. Frame: 3/16 inch thick steel, 2 inch long. Type 304 stainless steel for dishwasher exhaust duct.
   5. Finish: Factory baked acrylic paint.

D. Manufacturers: Titus Model SG-BG-SLV or approved.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 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.

### 3.05 automatic balancing DAMPERS (CAV as indicated on the drawings)

A. General: Install in supply and exhaust ductwork locations as shown on the Drawings. Install per manufacturer's installation instructions.

B. Location: Install dampers in accessible locations. Locate as far from outlet and inlet as possible.

C. Install 12 inch long orange colored 1/2 inch wide surveyors' tape on quadrant of volume dampers located above ceilings.

### 3.06 CEILING RADIATION 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 ceiling radiation damper, and combination fire/smoke dampers per IBC, IFC, NFPA 80, and NFPA 105.

### 3.07 ACCESS DOORS

A. General: Install at duct smoke detectors, motorized dampers, fire dampers, combination fire/smoke dampers, duct sensors, and plenums. Arrange door swings so that access doors open against air pressure.

B. Access Doors for Fire 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.

### 3.08 CLOTHES DRYER VENT LINT BOX and receptacle

A. Install to be accessible above dryer.

### 3.09 DUCT SECURITY BARS

A. Install security bars at duct penetrations which have dimensions greater than 8 inch and as indicated on the Drawings through security walls, floors of mechanical rooms and roofs. Field weld factory furnished angle to frame.

### 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.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes DOAS air handling 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.

### 1.02 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 762, Power Roof Ventilators for Restaurant Exhaust Applications.
22. UL 1995, Heating and Cooling Equipment.

### 1.03 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. DOAS Heat recovery units, custom.
   2. Roof exhaust fans.
   3. Ceiling exhaust fans.
   4. Fan drives.
   5. 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, 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. Field start-up test reports.
   2. 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.

### 1.04 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 233400 – Air Distribution Equipment: Remote temperature controller for heat recovery unit.

## PART 2 PRODUCTS

### 2.01 DOAS AIR HANDLING UNIT

A. Configuration: Fabricate as detailed on drawings.

B. Acoustics: Sound power levels (dB) for the unit shall not exceed the following specified levels. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

| | | | | | | |
|---|---|---|---|---|---|---|
| 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| 80 | 78 | 87 | 83 | 83 | 77 | 75 |
| 69 | 59 | 65 | 58 | 62 | 45 | 38 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| 71 | 71 | 75 | 70 | 68 | 67 | 63 |
| 60 | 52 | 53 | 45 | 47 | 35 | 26 |
| 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 79 | 77 | 86 | 82 | 82 | 76 | 74 |
| 68 | 58 | 64 | 57 | 61 | 44 | 37 |
| | | | | | | |
| 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| 70 | 70 | 74 | 69 | 67 | 66 | 62 |
| 59 | 51 | 52 | 44 | 46 | 34 | 25 |

**2.02 UNIT CONSTRUCTION**

A. Exterior casing shall be 24 GA G90 Galvanized Steel

B. Interior Casing shall be 24 GA G90 Galvanized Steel

C. Panels and access doors shall be constructed as a 2-inch nominal thick, with injected polyurethane foam insulation. R value shall be 6.5 per inch of wall thickness. Module to module assembly shall be accomplished with self-adhering foam gaskets. Manufacturer shall supply test data demonstrating less than L/240 deflection for an unsupported under 30” W.C pressure. Units that cannot demonstrate this deflection are unacceptable

D. Access Doors shall be flush mounted to cabinetry, with minimum of two hinges, locking latch and full size handle assembly.

E. Outdoor Unit construction includes 18GA Roof and Gutters.

F. Entire Unit shall be placed on a 4” 10 GA full perimeter base rail.

**2.03 SUPPLY / RETURN FANS**

A. Provide direct-drive airfoil plenum supply and return fans. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.

B. Bearings shall be self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Grease fittings shall be attached to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field.

C. Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on rubber-in-shear vibration type isolators inside cabinetry

**2.04 ELECTRICAL**

A. The air handler(s) shall bear an ETL listing label for the entire assembly. Units with only components bearing third party safety listing are unacceptable.

B. All controls shall be located on the side of the unit for ease of servicing.

C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. All wires shall be number tagged and cross-referenced to the wiring diagram for ease of troubleshooting.

D. Controls must include Self-Diagnostics with fault error and PLC error code. On board fault detection and diagnostics that senses and alerts when the damper is not operating correctly.

E. Fan Motors shall be ODP premium efficiency. Electrical characteristics shall be as shown in schedule.

F. Supplier shall provide and mount ABB variable speed drive with electrical characteristics as shown on project schedule.

G. Air handler manufacturer shall provide and mount a damper hand-off-auto (HOA) switch.

H. Unit shall be supplied with a single point power connection.

## 2.05 PARTICULATE FILTERS

A. Filter section with filter racks and guides with hinged and latching access doors for side loading and removal of filters

B. Filter media shall be UL 900 listed, Class I or Class II.

C. Flat arrangement with 2” deep pleated panel filters.

D. Supply Air pre-filter with MERV10 Rating

## 2.06 ENERGY RECOVERY

A. Dual Core$_{TM}$ Energy Recovery:

1. Unit shall be equipped with Dual Core$_{TM}$ energy recovery technology. The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery. Unit shall accomplish this recovery without a defrost cycle that will reduce the effectiveness of the device. Devices employing defrost cycles that bypass the energy recovery device, or reduce the effectiveness are not acceptable. Energy recovery device shall not require frost protection in applications down to -40 degrees.
2. Energy Cores shall be Generation 3, comprised of precisely corrugated 0.7mm (0.0276”) thick 1100 Series aluminum. Thinner aluminum is unacceptable to prevent deformation should cleaning be required to maintain indoor air quality. Spacing between plates shall be minimum 9 mm (0.35”) to assure that frost growth will not restrict airflow or reduce performance. Heat exchangers shall be a minimum or 995 mm (39”) long to assure minimum 60 second dwell time. Time between switchovers shall be minimum 60 seconds. Technologies employing shorter heat exchangers are not acceptable due to high cross leakage, and excessive cycling. Maximum allowable face velocity across heat exchangers shall be 490 fpm. Heat exchanger face velocities exceeding 490 fpm are not acceptable.
3. Heat exchangers shall be sectioned for a maximum section weight of 40 kg (88 lbs) so that the heat exchangers can be easily removed for cleaning to maintain indoor air quality. Sections weighing more are not acceptable. Heat exchanger that require special equipment to remove for cleaning (cranes, hoist etc.) are not acceptable. Heat exchangers shall be durable enough to handle high pressure power washing without deformation.
4. Unit Cross-leakage shall be maximum 1-3% as defined and tested in accordance with ASHRAE 84 Test Methods. Cross leakage exceeding this amount is unacceptable. Manufacturer shall produce testing data reflecting this performance in accordance with ASHRAE 84 test method. Testing must use the tracer gas method prescribed by ASHRAE 84.

5. Switchover damper section shall be comprised of multi section low leakage dampers operated by fast acting electric actuators. Pneumatic actuators are not acceptable. Damper switching times shall be no greater than 0.75 seconds. Dampers that do not switch within the specified times without objectionable noise are not acceptable. This switch over must limit any internal cross leakage below 3%. Test report must be provided showing that the damper configuration meets this requirement. Testing must use the tracer gas method prescribed by ASHRAE 84.
    a. Single blade damper sections are not acceptable. Each damper shall control one of the 4 airways, upper-horizontal, lower-horizontal, forward-vertical and rear-vertical. Dampers shall be capable of orienting to close off outside air to the building without needing external shut off dampers.
    b. Dampers shall also be capable of orienting to allow 100% recirculation of air without using heat recovery device for off peak or unoccupied heating modes. Units incapable of these operations without extra ductwork are not acceptable. Re-circ design must be capable of pre-warming both heat exchangers simultaneously for morning warm-up cycle. Strategies that only warm one heat exchanger is unacceptable.
    c. Damper seals shall be ½" heavy thickness EPDM bulb seal. Single blade seals are unacceptable due to high leakage and poor sealing.
    d. Damper bearings shall be heavy duty greasable pillow block flange bearings. Bronze or plastic bearings are not acceptable due to high cycle requirements. Bearings shall have a minimum diameter of ¾" bearings, maximum of 4 shafts per unit. Damper shafts shall be large diameter shafts meeting ¾" chromium shafts, maximum of 4 shafts per unit.
        1) 800-7000 CFM: ¾" Bearings, maximum of 4 shafts per unit
        2) 7,000 – 21,000 CFM: 1" Bearings, maximum of 4 shafts per unit
        3) 21,000 CFM and larger – 1" Bearings, maximum of 6 shafts per unit
6. Technologies employing smaller diameter shafts, or more shafts per unit are unacceptable as that would be considered light duty, and insufficient to withstand the demanding nature of the application.
    a. Damper manufacturer must provide written documentation that the dampers are capable of a minimum duty cycle of 500,000 cycles annually. Damper Manufacturer shall provide a written warranty on damper manufactures letterhead confirming the warranty.
    b. Recovery cycles shall be controlled by internal programmed thermostats measuring both supply and exhaust air and optimizing performance of both heat recovery and free cooling modes.

## 2.07 ROOF CURB

A. Manufacturer to provide an 18" tall flat bottom roof curb. Vertical supply and return air openings through the curb shall be provided.

## 2.08 MANUFACTURERS

A. The following manufacturers are approved for use. No substitutions will be permitted.
    1. Tempeff Dual Core™ as basis of design
    2. BKM Reverse Flow

## 2.09 ROOF EXHAUST FANS

A. Description: Factory assembled, roof mounted, direct drive as indicated on the Drawings with backward inclined centrifugal fan. UL 705 listed and labeled. See the Drawings for additional requirements.

B. Construction: Weatherproof, spun aluminum housing with internal supports, aluminum curb cap. Aluminum, non-overloading fan wheel. Wheel dynamically balanced per AMCA 204. Motor and drive assembly mounted on rubber vibration isolators.

C. Motor: Comply with requirements in Section 230513.

D. Fan Drive: Comply with Article “Fan Drives” in this section.

E. Bearings: Regreasable ball type in cast iron pillow block housing, L-50 life at 200,000 hours.

F. Note: In general, Seattle Energy Code requires a motorized damper. An access door is required in the connecting duct. Other curb heights are 8, 12, and 16 inch.

G. Accessories: Aluminum birdscreen with 85 percent free area, solid state variable speed controller mounted on junction box within housing for direct drive fans, and prefabricated metal insulated roof curb with cant strip. Minimum 10 inch above roof surface**.** Refer to architectural drawings for roof and roof insulation requirements.

H. Manufacturers: Greenheck Fan Corporation, model and capacities as scheduled on the drawings, Loren Cook Company,., or approved.

### 2.10 CEILING EXHAUST FANS

A. Description: Direct drive ceiling fan with forward curved centrifugal wheel. UL listed and labeled.

B. Airflow Arrangement: Integral bottom intake ceiling grille, designed for access to fan components, white plastic or aluminum construction.

C. Construction: Steel housing, 1/2-inch acoustic insulation liner, mounting brackets, backdraft damper with cushion stops, horizontal discharge. Baked enamel finish.

D. Motor: Shaded pole, sleeve bearing, permanently lubricated, suspension brackets with neoprene isolators. Comply with requirements in Section 230513.

E. Terminal Box: Mounted within housing with receptacle, plug and cord.

F. Roof Cap: Pitched roof application, integral flashing flange, birdscreen, and backdraft damper. Size for specific fan airflow. Black baked enamel finish.

G. Accessories:

1. Solid state variable speed controller factory or field installed and connected within housing.

H. Manufacturers: Greenheck Fan Corporation. SP-ASeries, Loren Cook Company, Air King, or approved.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

## 3.03 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.

## 3.04 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.

## 3.05 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. Exterior Mounted Air Handling Units: Attach roof curbs to roof and attach units to roof curbs. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints. Refer to architectural drawings for roof flashing.

D. Roof Exhaust Fans: Attach manufacturer’s roof curbs to roof and mount fans on roof curbs. Refer to architectural drawings for roof flashing.

E. Exterior Installations: Hot dip galvanized hardware and steel support frames for roof mounted fans.

## 3.06 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.

## 3.07 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.

### 3.08 ADJUSTING

A. Lubricate bearings with oil or grease as recommended by manufacturer.

B. Adjust damper linkages for proper damper operation.

### 3.09 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**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes grilles, diffusers caps, 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.

### 1.02 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.

### 1.03 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. Roof caps.

## PART 2 PRODUCTS

### 2.01 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.

### 2.02 ROOF CAPS

A. Clothes Dryer Vent Cap:
   1. Description: Weathertight aluminum construction, integral birdscreen and backdraft damper, curb cap.
   2. Roof Curb: 18 inch high insulated curb for flat or pitched roofs as applicable.
   3. Manufacturers: Greenheck Fan Corp.Model RCC-7, PennBarry™, or approved.

B. Dome Type Roof Cap:
   1. Description: Spun aluminum construction, low silhouette, curb cap, aluminum birdscreen, and motorized damper.
   2. Roof Curb: 18 inch high insulated curb for flat or pitched roofs as applicable.
   3. Manufacturers: PennBarry™ Weather Cap, Greenheck Fan Corp., or approved.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

### 3.03 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. Secure roof curbs for roof caps and secure caps to top of curbs.

## 3.04 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.

## 3.05 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**

## PART 1 GENERAL

### 1.01 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.

### 1.02 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 900, Standard for Air Filter Units.
   4. UL 916, Standard for Energy Management System.

### 1.03 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. Replaceable pre-filters and filters.
   2. Final filters.
   3. Filter housings and frames.
   4. Resistance indicator.
   5. Filters during construction.
   6. 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.

### 1.04 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

### 1.05 SPARE MEDIA

A. For Air Handling Units, Heat Recovery Units, Packaged HVAC Equipment, Similar Equipment with Filters: Three sets for each type of filter. One for initial installation, one installed prior to TAB work specified in Section 230593, 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

### 2.01 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.

### 2.02 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, MERV11 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.

### 2.03 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, filter, and final filter as specified in this Section and as indicated on the Drawings. Include integral static pressure tap between pre--filter and final filter.
   3. Manufacturers: Camfil Glide/Pack, AAF International, Flanders® Corporation, or approved.

### 2.04 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 2 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 2002 or approved.

### 2.05 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

### 3.01 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.

### 3.02 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.

### 3.03 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.

### 3.04 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

### 3.05 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**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The Work includes packaged HVAC equipment with mechanical cooling capabilities and associated appurtenances and refrigerant piping for 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.

### 1.02 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 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
3. AHRI 210/240, Performance Rating of Unitary Air-Conditioning and Air Source Heat Pump Equipment.
4. AHRI 270, Sound Rating of Outdoor Unitary Equipment.
5. AHRI 340/360, Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
6. AHRI 390, Single Package Vertical Air-Conditioners and Heat Pumps.
7. ASCE 7, Minimum Design Loads For Buildings and other Structures.
8. ASTM B 117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
9. MSS SP- 58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
10. MSS SP- 69, Pipe Hangers Supports – Selection and Application.
11. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
12. UL 1995, Heating and Cooling Equipment.

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

### 1.04 WARRANTY

A. General: Warrant variable refrigerant flow (VRV) system components for 10 years after Substantial Completion date. Warranty shall cover material, labor, and travel time. Make available replacement within 48 hours of initial notification.

### 1.05 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

### 2.01 VARIABLE REFRIGERANT FLOW (VRF) SPLIT HEAT PUMP SYSTEM 6 THROUGH 42 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 switch, 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 (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.

E. 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.

F. 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.

G. 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.

H. Manufacturers: Mitsubishi Electric Corporation, equipment as scheduled on the drawings, LG Electronics Multi V™ IV Series, Daikin, Trane®, or approved.

## 2.02 REFRIGERANT PIPING FOR 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.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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.

### 3.03 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.

C. Installation: Equipment manufacturer shall supervise installation of process cooling equipment and verify that installation conforms to his requirements.

### 3.04 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.

### 3.05 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.

### 3.06 INSTALLATION OF 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.

### 3.07 START-UP SERVICES

A. Equipment manufacturer's authorized representative shall perform start-up services of packaged HVAC equipment 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.

### 3.08 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

### 3.09 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**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of electrical work. This section applies to all Divisions 26, 27, and 28 sections.

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

### 1.02 CODES AND STANDARDS

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

B. Conform to applicable industry standards, UL standards, NEMA standards, and other standards as noted.
   1. Notify the A/E of deviations in 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. Contractor to comply with requirements of the Contract Documents which may exceed code requirements and not contrary to same.

C. Operating Conditions:
   1. Temperature: Minus 20 deg C to plus 40 deg C.
   2. Altitude: Up to 3,300 feet (1,000 meters).

### 1.03 PERMIT INFORMATION

A. Permit Application: Arrange for and pay for all required permits, fees, and inspections required for work included in Division 26, 27, and 28.

B. Permit Submittal Plan Review: Submit the following to the AHJ as required to support the permit application:
   1. Fire Alarm Permit: Submit Shop drawings

C. Approved Permit Plans Printing: Print and have available for the inspector a full size color set of the approved plan review drawings. A digital set of approved drawings will be provided electronically and will be the same size and sheet count as the Bid Documents.

### 1.04 SUBMITTALS

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

B. 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 260519 under one submittal number and products for Section 260533 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. Submit signed letter indicating 3D model coordination has started and will continue through construction. 3D model not required to be submitted/reviewed during construction phase.
4. Partial product submittals not acceptable and will be returned without review except as follows:
    a. Section 260573 Power Studies including representative one-line diagram of distribution system (with bus numbers as described herein) indicating which devices will be presented in protective device coordination study and indicate additional information required to complete the study.
    b. Section 260923 Lighting Controls including products and materials for first submittal and Shop Drawings for second submittal.
    c. Sections 265100 Lighting and 265561 Stage Lighting Systems including products and materials for first submittal and Shop Drawings for second submittal.
    d. Section 283111 Fire Alarm and Detection Systems including products and materials for first submittal and Shop Drawings for second submittal.
    e. Long lead items.
    f. Site and underground work.
5. 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.
6. 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.

C. Shop Drawings:
1. Submit as specified in the individual specification sections. Submit minimum 30 days prior to starting fabrication on installation work. Do not fabricate on install until reviewed by the A/E. Include complete location dimensions, and hanger and support sizes and dimensions.
2. “Typical” drawings and wiring diagrams not accepted unless they specifically apply to this project.
3. Provide drawings at sufficient scale to show details clearly on same size sheets as Drawings.
4. Show required coordination with work of other trades.
5. Identify details and show their locations in Project.
6. Include description of configuration and operation of proposed systems.
7. Include outline drawings of proposed equipment in plan and elevation views including overall dimensions, weights, and clearance required.
8. Include one-line electrical diagrams required for control and sensing.
9. Request floor plan backgrounds in electronic format from the A/E.
10. Direct use of the Drawings as the basis of Contractor’s prepared Shop Drawings not acceptable.
11. Format:
    a. Adobe PDF file format.

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

E. As-Built Drawings: Daily updates and markups that reflect all changes made in the specifications and working drawings during the construction process, and show the exact dimensions, geometry, and location of all elements of the work completed under the contract.

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 a package prior to Substantial Completion.

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

I. Record Drawings: Conformed set of as-builts developed during the construction process. Provide a single digital copy for each sheet in the contract documents and developed at the end of the construction phase. Comply with Article "Record Drawings" in this section.

J. Schedule of Values:
   1. Comply with the requirements in Division 01 with additional requirements as indicated in this paragraph.
   2. Include costs in Schedule of Values as follows:
      a. Mobilization.
      b. Submittals.
      c. Electrical Permit.
      d. 3D Coordination
      e. Electrical Site – Utility Provisions, Material.
      f. Electrical Site – Utility Provisions, Labor.
      g. Electrical Site – Site Lighting Rough In, Material.
      h. Electrical Site – Site Lighting Rough In, Labor.
      i. Electrical Site – Power and Low Voltage, Material.
      j. Electrical Site – Power and Low Voltage, Labor.
      k. Lighting Systems – Fixtures & Lamps Material.
      l. Lighting Systems – Fixtures & Lamps Labor.
      m. Lighting Systems – Branch Circuit Raceway Rough-in, Material.
      n. Lighting Systems – Branch Circuit Raceway Rough-in, Labor.
      o. Lighting Systems – Branch Circuit Wiring, Material.
      p. Lighting Systems – Branch Circuit Wiring Labor.
      q. Lighting Systems – Devices & Trim, Material.
      r. Lighting Systems – Devices & Trim, Labor.
      s. Power Systems – Switchgear, Disconnects, Material.
      t. Power Systems – Switchgear, Disconnects, Labor.
      u. Power Systems – Feeder Raceway Rough-in, Material.
      v. Power Systems – Feeder Raceway Rough-in, Labor.
      w. Power Systems – Feeder Conductor, Material.
      x. Power Systems – Feeder Conductor, Labor.
      y. Power Systems – Equipment Connections.
      z. Power Systems – Branch Circuit Raceway Rough-in, Material.
      aa. Power Systems – Branch Circuit Raceway Rough-in, Labor.

bb. Power Systems – Branch Circuit Wiring, Material.
cc. Power Systems – Branch Circuit Wiring, Labor.
dd. Power Systems – Devices & Trim, Material.
ee. Power Systems – Devices & Trim, Labor.
ff. Low Voltage – Fire Alarm Rough-in, Material.
gg. Low Voltage – Fire Alarm Rough-in, Labor.
hh. Low Voltage – Fire Alarm Trim, Material.
ii. Low Voltage – Fire Alarm Trim, Labor.
jj. Low Voltage – Telecommunications Pathway Rough-in, Material.
kk. Low Voltage – Telecommunications Pathway Rough-in, Labor.
ll. Low Voltage – Telecommunications Cabling, Material.
mm. Low Voltage – Telecommunications Cabling, Labor.
nn. Low Voltage – Performance Audio Visual, Material.
oo. Low Voltage – Performance Audio Visual, Labor.
pp. Low Voltage – Performance Sound, Material.
qq. Low Voltage – Performance Sound, Labor.
rr. Low Voltage – Intercom and Clock Rough-in, Material.
ss. Low Voltage – Intercom and Clock Rough-in, Labor.
tt. Low Voltage – Intercom and Clock Trim, Material.
uu. Low Voltage – Intercom and Clock Trim, Labor.
vv. Low Voltage – Intrusion Detection, Material.
ww. Low Voltage – Intrusion Detection, Labor.
xx. Low Voltage – Access Control, Material.
yy. Low Voltage – Access Control, Labor.
zz. Low Voltage – Security Video, Material.
aaa. Low Voltage – Security Video, Labor.
bbb. Low Voltage – Rescue Assistance Signal, Material.
ccc. Low Voltage – Rescue Assistance Signal, Labor.
ddd. Low Voltage – Emergency Responder Radio, Material.
eee. Low Voltage – Emergency Responder Radio, Labor.
fff. Punch List and Close Out.
ggg. Testing Commissioning and Training.

## 1.05 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division 01 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 AHJ adopted codes, rules, and ordinances and additional codes as specified herein.

D. “Concealed” means spaces out of sight. For example, above ceilings, below floors, between double walls, furred-in areas, pipe and duct shafts, and similar spaces.

E. The word “Contractor”, as used in Divisions 26, 27, and 28 sections, means the electrical subcontractor.

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

G. “Demolition”, “Demo”, “Demolish” means to disconnect, remove and properly dispose of existing devices, components, equipment.

H. “Directed”, “Requested”, “Accepted”, and Similar Terms means these terms imply “by the A/E” unless otherwise indicated.

I. “Exposed” means open to view. For example, raceways installed in a tunnel or raceways installed in a room and not covered by other construction.

J. “Furnish” means supply and deliver to the project site ready for unloading, unpacking, assembly, installation, and similar activities.

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

L. “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.

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

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

O. “Structural Members” means all above and below grade elements associated with the structural support of the building or structure.

P. “Substantial Completion” means that the entire project (or readily definable portion thereof if so designated in the Contracted 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 the purpose intended. Refer to Divisions 00 and 01 for additional requirements.

Q. “Work” or “Project” means entire scope of work required by the Contract Documents.

R. Abbreviations:

| | |
|---|---|
| A/E | Architect |
| ADS | Acoustical Distinguishable Space |
| AFCI | Arc Fault Circuit Interrupter |
| AHJ | Authorities Having Jurisdiction |
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| ATP | Acceptance Test Procedure |
| BMS | Building Management System |
| BOM | Bill-of-Material |
| C | Degrees Celsius |
| CEC | Canadian Electrical Code |
| CCT | Correlated Color Temperature |
| CIS | Common Intelligibility Scale |
| CSA | Canadian Standards Association |
| CR | Controlled Receptacle |
| CRI | Color Rendering Index |
| CU | Coefficient of Utilization |
| DAS | Distributed Antenna System |
| EBS | Educational Broadband Service |

| | |
|---|---|
| EMS | Energy Management System |
| EMT | Electrical Metallic Tubing |
| EPO | Emergency Power Off |
| ETL | Environmental Technology Laboratory |
| EUSERC | Electric Utility Service Equipment Requirements |
| F | Degrees Fahrenheit |
| FC | Foot-candle |
| FM | Factory Mutual Engineering Corporation |
| GB | Ground Fault Circuit Interrupter Breaker |
| GFCI | Ground Fault Circuit Interrupter |
| GFI | Ground Fault Circuit Interrupter |
| GUI | Graphical User Interface |
| HDPE | High-density polyethylene |
| HID | High-intensity discharge |
| HVAC | Heating, Ventilation and Air Conditioning |
| IC | Insulation contact |
| IBC | International Building Code |
| IDF | Intermediate distribution frame |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| IES | Illuminating Engineering Society |
| IMC | Intermediate Metal Conduit |
| K | Kelvin |
| kVA | Kilo Volt Amps |
| LED | Light-emitting diode |
| LPI | Lightning Protection Institute |
| MC | Metal Clad |
| MDF | Main distribution frame |
| NEC | National Electrical Code, NFPA 70 (latest adopted edition with Amendments) |
| NEMA | National Electrical Manufacturer's Association |
| NETA | International Electrical Testing Association |
| NFPA | National Fire Protection Association |
| NRTL | Nationally Recognized Test Laboratory |
| OSHA | Occupational Safety and Health Administration |
| PCB | Polychlorinated Biphenyl |
| PDU | Power Distribution Units |
| PF | Power factor |
| RMC | Rigid Metal Conduit |
| RMS | Root Mean Square |
| RTRC | Reinforced thermosetting resin conduit |
| SCCR | Short Circuit Current Rating |
| SPD | Surge Protective Devices |
| STC | Factory Standard Test Condition |
| STI | Sound transmission index |
| STIPA | STI for public address systems |
| TCLP | Toxicity characteristic leaching procedure |
| THD | Total Harmonic Distortion |
| TIA | Telecommunications Industry Association |
| UL | Underwriters Laboratories Inc. |
| UPS | Uninterruptible Power Supply |
| V | Volts |
| VOIP | Voice Over Internet Protocol |
| VRLA | Valve Regulated Lead Acid Batteries |

## 1.06 MATERIALS

A. Where two or more manufacturers are listed, select for use any of those listed. The first mentioned, in general, was used as the basis of design. Bids on any manufacturer named acceptable as long as that manufacturer meets every aspect of the Contract Documents. 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. Include costs in base bid for required redesign work by A/E to accommodate proposed Product. 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.

## 1.07 STANDARDS OF QUALITY

A. Materials and Equipment: UL listed and labeled or other AHJ approved testing laboratory and in compliance with other industry standards as specified.

B. Provide manufacture's regularly catalogued items and supply as a 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 the manufacturer's recommendations and best trade practices.

C. Provide new products unless indicated otherwise in the Contract Documents.

D. Fabricator and Manufacturer Qualifications: Specialists with at least 5 years' experience and regularly engaged in manufacture of equipment and materials specified.

E. Furnish products of a single manufacturer for items which are used in quantity. A Product, for the purpose of this paragraph, is an assembly of components such as switchboards, transformers, panelboards, and similar items. Materials such as wire and cable, raceways, outlet boxes, and similar items not requiring maintenance are not included in the single manufacturer requirement of this paragraph.

F. Installer Qualifications: Specialists with at least 5 years' experience and regularly engaged in the installation of the system, equipment, and materials specified. Where required by the AHJ, employ licensed trades persons.

## 1.08 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, the approval is given with the understanding that the Bidder:
   1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
   2. Will provide the same warranty for the Substitution as for the 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 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 Shop Drawings or product data submittals, without separate written prior approval, or when approval will require revision to the Contract Documents.

**1.09 DRAWINGS AND SPECIFICATIONS**

A. General: The electrical drawings are diagrammatic. Complete details of building features which affect electrical installation 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 Work: Drawings do not show the exact characteristics of the work including, physical arrangement of equipment, lengths of wiring or conduit runs. Base work on actual field measurements and conditions. Provide work required to complete the 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. Since the Drawings of floor, wall, and ceiling installation are made at small scale, outlets, devices, equipment, and similar items are indicated only in their approximate location. Locate outlets and apparatus symmetrically on floors, walls, and ceilings where not dimensioned and coordinate such locations with work of other trades to prevent interferences.

E. Discrepancies: Field verify dimensions and existing conditions prior to performing 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). Provide corrective work required after discovery of such discrepancies, inconsistencies, or ambiguities at no additional cost to the Owner.

F. Specifications: These specifications are written in imperative mood and streamlined form. The 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 as indicated in this article.

B. Prepare As-Built drawings: Red line As-Built Drawing prints in digital or hand drawn format (pencil and black pen not acceptable). Include:
   1. Corrections and Changes: Record during the progress of the Work, showing work as actually installed.
      a. Show the measured locations of portions of the Work and changes the Contractor has made.
      b. In general, tolerance plus or minus 1'-0" from actual location.
      c. Show addendum items, change orders, clarifications, supplemental instructions, and deviations from the Drawings. Show device or equipment changes and indicate where the change was originated. Only indicating the document where the change originated from will not be accepted.
   2. Updates: Neatly hand-draft on daily basis and kept readily available at project site. Updates are subject to review by the A/E on a regular basis throughout construction. Updates are to include the following at a minimum:
      a. Feeder routing indicating upstream and downstream equipment.
      b. Installation locations for underground raceways and where they transition to above grade.
      c. Device locations and mounting heights.
      d. Junction and pull boxes with two or more home runs.
      e. Junction and pull boxes with one home run.
      f. Circuit information.
      g. Shop Drawings: Update shop drawings with changes or deviations from the Original Shop Drawings. Provide updates to manufacturer/vendor for inclusion in Record Drawings.

C. Record Drawings: Develop a digital set of Record Drawings for the project utilizing the as-built drawings. Digital Record Drawings can be in AutoCAD or PDF format. At end of construction, check drawings for completeness and accuracy.

D. Shop Drawing Record Drawings: Provide updated shop drawings based on As-Built drawings for use as Record Drawings.

E. Per project closeout procedures, submit in Digital Record Drawings and a copy of the As-Builts. Note each sheet as "RECORD DRAWING".

F. 3D Coordination Model: Include fully coordinated 3D model.

## 1.11 COORDINATION

A. Coordinate Divisions 26, 27, and 28 work with other trades.

B. Develop 3D model for coordination with other trades.
   1. Format: 3D drawings using industry recognized software that is compatible with general contractor's 3D software.
   2. Include electrical conduits, cable trays, electrical equipment, lighting fixtures and other items to be installed in ceilings, full height walls, and other items necessary to coordinate installation.
   3. Attend coordination meetings and make modifications to the 3D model until all items have been coordinated.

C. Be aware of restricted space for installation of electrical systems. Include offsets and perform rerouting and coordination to fit elements in available space. Include provisions for such requirements in bid.

D. Electrical equipment and systems shown are based on existing drawings as available and on limited project site observations to the 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.

E. Coordinate raceway 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.

F. Existing Conditions:
   1. General Construction:
      a. Installation of electrical, telecommunications, and electronic safety and security 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 the architectural drawings may require removal, relocation, and reinstallation of existing electrical, telecommunications, electronic safety and security work. Since existing conditions cannot be completely detailed on the Drawings, survey the site and perform required Work at no additional cost to the Owner.
   2. This project may require work in the presence of asbestos containing material (ACM). Division 26 does not provide for or cover the identification, removal, incapsulation, or disposal of such material. If the presence of ACM is suspected, notify the Owner prior to proceeding with in the vicinity of ACM.

G. Be responsible for beam penetrations as they relate to the electrical work. Submit sizes and locations to the structural engineer for review and determination of structural details.

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

I. Refer to architectural and structural drawings for location of expansion and seismic joints. Provide flexible loops for raceways and cable trays crossing expansion and seismic joints.

**1.12 WORKMANSHIP**

A. Provide work in accordance with best trade practices. Remove substandard workmanship and provide new material at no extra cost to the Owner.

**1.13 SITE VISIT**

A. Visit site during bidding period to note conditions affecting installation of 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 bid for off hours labor, reassembly, and field testing.

## 1.14 CERTIFICATION

A. By submitting a bid for the electrical, telecommunications, electronic safety and security 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 specifications. In addition, they have determined that the Drawings and Specifications are adequate to complete the electrical systems and that they can provide a complete finished and operable system in accordance with the Contract Documents.
2. That they have had a reasonable opportunity to discover any ambiguities in the Contract Documents and such ambiguities have been brought to the attention of the A/E in writing prior to submitting the bid.
3. That they have reviewed the project progress schedule with the general contractor, fully understand the 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 the schedule requirements.
4. That there may be changes to the scope of work and that they understand that any proposal submitted for performance of additional work includes 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 Work and address manufacturer's recommended clearances for service access, maintenance, and replacement of equipment in a manner that is compatible with work of other trades in the same area.
6. That routing of elements of electrical systems shown on the Drawings is schematic only and that offsets and rerouting probably will be required in installation and that labor and materials have been included for such in their bids.
7. 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 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.
8. 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 work required under the Contract Documents, and in respects to complete the contract work to the satisfaction of the A/E.
9. That they include in their bids costs to furnish bonds as specified in the Contract Documents.

## 1.15 WARRANTY

A. Conform to requirements in General Conditions, Supplementary Conditions, and Division 01. Where not so prescribed or defined, provide for a period of 1 year.

B. Warranty periods within Divisions 26, 27, and 28 are based on industry standard warranty periods and commence on the Substantial Completion date. Provide extended factory warranties as required to account for the difference between standard factory warranty start time and date of the Substantial Completion.

## 1.16 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. Operation and Maintenance Data: Obtain from the Owner operation and maintenance data for the 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 the FOIC equipment.
   2. Include one year warranty on FOIC equipment starting at Substantial Completion regardless of shorter time limits by FOIC suppliers.

## 1.17 DEMONSTRATION

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

B. Following installation of electrical 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 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.

## 1.18 SUBSTANTIAL COMPLETION

A. Comply with requirements in Division 01.

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

## 1.19 ALTERNATES

A. General: See Bid Form and Alternates described in Division 01 for possible effect on work of Divisions 26, 27, and 28.

## 1.20 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. 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 work in the existing building with respect for the 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, wiring, lighting, and similar systems and connect to existing systems to keep existing electrical systems in operation to service areas that need to remain occupied.

## 1.21 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals for equipment and materials furnished under Divisions 26, 27, and 28.

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

C. Submit one hard copy and one electronic PDF format of Operation and Maintenance Manuals for review at least 4 weeks prior to Substantial Completion date. Assemble hard copy Operation and Maintenance Manual in 3-ring binder(s). Use multiple binders if pages in a single binder would exceed 4 inch thickness. Separate binders for each category, such as Electrical, Telecommunications, and Electronic Safety and Security. Where one subject matter encompasses more than one binder, differentiate by volume numbers. Include indexed tabs for each binder. Engrave cover with the project title in 1/2 inch high letters and name and address of the Contractor in 1/4 inch high letters. Provide same information in 1/8 inch high letters on spine.

D. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Include serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, and similar information. Provide individual sheet for each item of equipment. (Example: If 2 items of equipment A and D appear on the same sheet, provide individual sheet for each unit specified.)

E. Include the Following Information:
   1. Identifying name and mark number.
   2. Certified outline drawings and Shop Drawings.
   3. Parts list.
   4. Performance curves and data.
   5. Wiring diagrams.
   6. Manufacturer's recommended operating and maintenance instructions.
   7. Vendor's name, address and telephone number for all parts and equipment.
   8. Name, address and telephone number of Contractor performing the work.
   9. Test reports.
   10. Product data and Record Drawings.

## 1.22 TESTING

A. Comply with requirements in Section 260810.

## 1.23 PROJECT TRAINING

A. Upon completion and testing of equipment and system installation, assemble equipment factory representatives and subcontractors for system training with Owner's representatives as required in specific specification sections.

B. Provide representative and subcontractor assistance in start-up, check out, and training for their respective system and remain on-site until the total system operation is thoroughly reviewed by the Owner's representatives and are thoroughly trained. Return for additional training sessions as required to completely train Owner's Representatives.

C. Provide factory representative and system subcontractor personal instruction on operating and maintenance of their equipment to the Owner's maintenance and operation personnel. To certify acceptance of operation and instruction by the Owner's representative, prepare a written statement as follows:

1. This is to certify that the factory representative and system subcontractor for each system listed below have performed start-up and final check out of their respective systems.
2. The Owner's maintenance and operation personnel have received complete and thorough instruction in the operation and maintenance of each system.

| SYSTEM | FACTORY REPRESENTATIVE |
|---|---|
| (List systems included) | (List name and address of factory representative.) |

| Owner's Representative | Contractor |
|---|---|

D. Submit copy of acceptance to A/E.

## 1.24 PUNCHLIST AND FINAL REVIEWS

A. Provide electrical foreman assistance at the time of punchlist and final reviews and accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested to allow review of entire electrical system.

B. Punch List: Review each punch list item; update field conditions to address items or provide comment response for reason the item has not been addressed in the field.

## 1.25 PROJECT CLOSEOUT

A. Include costs of engineering services required beyond the final completion date paid by the Contractor at a rate of $150 per hour.

B. Punchlists by A/E at Substantial Completion and final completion dates. Submit Record Drawings and final Operation and Maintenance Manuals prior to Substantial Completion date. Subsequent reviews paid by the Contractor at a rate of $150 per hour.

## 1.26 COMMISSIONING SUPPORT

A. Comply with requirements in Sections 019113 and 260810.

B. Division 26 subcontractor: assist in developing final Functional Test Procedures as specified in Sections 019113 and 260810.

C. Start-up and testing services and Functional Performance Testing provided by equipment manufacturer’s authorized representatives as specified in Sections 019113 and 260810.

D. Submit equipment start-up and test procedures and preliminary Operation and Maintenance Manuals to the Commissioning Authority. Submit under separate bound cover.

**PART 2 PRODUCTS**

Not used.

**PART 3 EXECUTION**

Not used.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes basic electrical requirements specifically applicable to Divisions 26, 27, and 28 sections including general material and installation requirements and site work.

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.

### 1.02 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. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$).

### 1.03 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.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Furnish specified items acceptable to AHJ as suitable for intended use.

B. New, unless otherwise indicated, free from defects and the standard products of reputable manufacturers regularly engaged in production of such equipment.

C. Furnish similar items of equipment by same manufacturer.

D. Materials and Equipment: UL listed and labeled or other AHJ approved testing laboratory and in compliance with other industry standards as specified.

E. Remove rejected or damaged material from site.

F. Samples may be required for non-standard or substituted items before installation. Submit samples as required in specific specification sections.

G. Furnish required items necessary for installation and testing procedures.

### 2.02 POSTED INSTRUCTIONS

A. Posted Operating Instructions: Furnish simplified, consolidated equipment control and power diagrams. Graphically represent entire system and actual equipment installed. Include concise written instructions on how to start and stop systems. Show settings and conditions to be observed. Indicate what control adjustments are to be made or maintained by the operator.
   1. Include control diagrams and specific operating instructions.
   2. Indicate how to energize each major component of systems. Show what action must be taken in an emergency, how to restore power following an outage, and what precautions to be taken when maintenance is required.
   3. Include photographic or comparable non-fading reproductions, either framed under glass or encased in non-discoloring plastic.
   4. Include one-line diagrams of electric power distribution riser.

B. Copies of operating instructions shall be used with Operation and Maintenance Manuals as basis in training Owner's employees in the operation and maintenance of systems and related installed equipment.

### 2.03 ENCLOSURES

A. NEMA Type 1 – Dry Interior locations unless otherwise noted on drawings or as specified below.

B. NEMA 3R Weather-proof/Rain-proof – Windblown rain, sleet, ice – Provide in all locations where exposed to moisture unless otherwise noted.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify installation conditions as satisfactory to receive work of the various sections. Do not install until unsatisfactory conditions are corrected.

### 3.02 INSPECTIONS

A. Confirm that installations have been inspected before enclosure within building features, buried, or otherwise hidden from view. Pay costs associated with uncovering or exposing installations and features not previously inspected and for repair to exposed surfaces.

### 3.03 PREPARATION

A. Protect surrounding areas and surfaces to prevent damage as work is installed.

B. Obtain equipment roughing-in dimensions from approved Shop Drawings or actual measurements.

C. Be familiar with the location of other trade's equipment. Eliminate conflicts. Check door swings before installing switches. Locate switches on strike side of doors unless noted otherwise.

D. Layout electrical, telecommunications, and electronic safety and security work in advance of construction to eliminate unnecessary cutting, drilling, channeling, and similar activities. Where such cutting, drilling, channeling and similar activities become necessary for proper installation, perform with care using skilled mechanics of trades involved. Repair damage to building and equipment at no additional cost to the Owner.

E. Perform cutting work of other trades only with consent of that trade. Cutting structural members not permitted without consent of the A/E.

**3.04 INSTALLATION**

A. Install Work as specified and in accordance with the Drawings and manufacturer's instructions. Where these conflict, manufacturer's instructions govern.

B. Review Architectural, Mechanical and other applicable drawings and applicable Shop Drawings to prevent switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, and similar items, or from being located in whiteboards, tackboards, glass panels, and similar items. Relocate electrical devices and connections as directed by the A/E at no additional cost to the Owner if the work is not properly coordinated.

C. Where conduit, outlets, and apparatus are encased in concrete, locate and secure at point of installation. Check locations of electrical items before and after concrete and masonry installation and relocate displaced items.

D. Provide block-outs, sleeves, demolition work, and similar items required for installation of Work specified in this division.

**3.05 WORKMANSHIP**

A. Work and materials will be subject to observation at any time by the Owner and the A/E.

B. Install material and equipment in accordance with manufacturer's instructions. Provide calibrated torque wrenches and screwdrivers as required.

C. Cutting and Patching: Do not weld to, cut, or notch structural members or building surfaces without approval of the A/E. Restore surfaces neatly to original condition after cutting, channeling, chasing, and drilling of walls, partitions, ceilings, paving, and anchorage of conduit, raceways, and other electrical equipment.

**3.06 WELDING, CUTTING, AND DRILLING**

A. Perform in accordance with American Welding Society Standards.

**3.01 EARTHWORK**

A. Perform earthwork required for installation of electrical work below grade. Provide earthwork meeting requirements in this article and Division 31, whichever is most stringent. Provide earthwork meeting requirements of the serving utility company where earthwork is related to utility infrastructure.

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. Place and maintain barricades, warnings, construction signs, illumination and guards as required during periods of open excavation to protect persons from injury and to avoid property damage. Provide bracing and shoring as necessary to maintain stability of excavation and to comply with safety codes.

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

E. 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. Refer to other sections for additional requirements for excavating.

F. Store excavated material (temporarily) near excavation in manner which will not interfere with or damage excavation or other work.

G. Retain excavated material which complies with requirements for backfill material. Dispose of excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site and dispose of in lawful manner.

H. Backfill trenches only after observation by the A/E. Install backfill material under, around, and between conduit and sides of trench by hand, shovel tamped in place. Cover in 6 inch layers to 12 inch thickness over top of conduit or cabling. For final backfill, fill and tamp remainder of backfill material in 6 inch layers. Provide backfill materials as follows for buried conduit or cable (other than concrete encased):
   1. Backfill below, on sides of, and over conduit or cable: Sand or pea gravel. Minimum thickness of 6 inches above, below and at sides of outer conduits. Minimum 3” spacing between conduits.
   2. Backfill to within 6 inches of Final Grade: Soil material suitable for compacting to required densities. Per Division 31requirements.
   3. Backfill for top 6 Inches of excavation: Top soil except where excavations occur below paved or gravel area provide compacted gravel backfill or surface area as indicated.

I. 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 1 and 31.
   2. Take special care in compacting under services where they enter building to prevent settling. Contractor fully responsible for damage to piping and property as a result of settling around service conduit and cabling.

J. Subsidence: Where subsidence is measurable or observable at electrical 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.

## 3.02 CONCRETE BASES

A. Unless noted otherwise, provide 4 inch high reinforced concrete bases for floor mounted and floor standing electrical equipment, including generators, transformers, switchgear, battery racks, motor control centers, and similar equipment. Extend bases 4 inches beyond equipment or mounting rails in each direction unless noted otherwise on the Drawings.

B. Concrete bases shall be provided under Division 26. Coordinate size and location of bases and provide required anchor bolts, sleeves, and templates required to obtain proper installation.

C. Provide concrete pads and vaults for power company furnished pad mounted transformers in accordance with power company clearance requirements.

## 3.03 CLEANING

A. Clean equipment, conduit, and fittings and remove packing cartons and other debris created by Divisions 26, 27, and 28 Work.

B. Before Substantial Completion, carefully clean equipment, fixtures, exposed raceways and similar items. Remove construction labels, dirt, cuttings, paint, plaster, mortar, concrete, and similar items. Clean fixtures, interiors and exteriors of equipment and raceways.

## 3.04 IDENTIFICATION

A. Provide nameplates and decals required to identify equipment and components, comply with requirements in Section 260553.

B. Mount operating instructions and diagrams near equipment or elsewhere as otherwise designated by the Owner.

## 3.05 PROTECTION

A. Protect equipment during and after electrical hookup, painting, and final testing.

## 3.06 REMOVAL AND REPLACEMENT OF EXISTING ACCESSIBLE CEILING PANELS

A. General: Remove and reinstall necessary panels in existing accessible ceilings to install electrical work in areas where no architectural work is being performed. Where existing ceiling panels are damaged, replace with new to match existing. After ceiling removal and reinstallation is complete, ceiling system appearance shall match adjacent similar ceilings that have not been removed.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes final electrical connection to equipment having electrical requirements. Contractor shall make final connections for Owner furnished equipment including switches, receptacles, and similar items. See other applicable specification sections for building temperature control wiring requirements specified in Divisions 21, 22, and 23.

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

C. Connection to Equipment Specified in Divisions 21, 22, and 23 as Follows unless Specified Otherwise in Divisions 21, 22, and 23:

1. For motorized only equipment with built-in controllers (packaged equipment), Connect power and provide an external disconnect at equipment. Division 23 will provide control wiring.
2. For motorized only equipment with external controller (non-packaged equipment), provide external motor controller, disconnect switch, and make power wiring complete to equipment. Division 23 will provide control wiring.
3. For electric duct heaters with built-in controllers (packaged type equipment), connect power complete and provide external disconnect switch at equipment. Division 23 will provide control wiring.
4. For electric duct heaters with remote controllers (non-packaged type equipment), provide external controller, disconnect switch, and make power wiring to equipment. Division 23 will provide control wiring.
5. For combination motorized and electric heating packaged units specified with built in controllers and specified with “single point electrical connection” under Division 23, connect power and provide external disconnect switch. Division 23 will provide control wiring.
6. For equipment requiring a full voltage non-reversing starter, include as a combination disconnect unit.

D. Refer to Division 23 sections for control system wiring.

E. Refer to sections of other divisions for specific individual equipment power requirements.

A. Make final connection to kitchen equipment.

### 1.02 QUALITY ASSURANCE

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

B. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.

C. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements and to applicable Division 26 sections.

D. UL Labels: Provide electrical connection products and materials which have been UL listed and labeled.

## PART 2 PRODUCTS

### 2.01 ELECTRICAL CONNECTIONS MATERIALS

A. For each electrical connection indicated, include complete assembly of materials, including but not limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories to complete splices, terminations, and connections.

B. Comply with requirements in Section 260519 for wires and cables, Section 260533 for raceway systems, and Section 262726 for wiring devices.

C. Include Final Connections for Equipment Consistent with the Following:
   1. Permanently Installed Fixed Equipment: Flexible seal-tite conduit from branch circuit terminal equipment, and raceway to equipment, control cabinet, terminal junction box, and wiring terminals. Totally enclose wiring in raceway.
   2. Movable and/or Portable Equipment: Wiring device, cord cap, and multi-conductor cord suitable for equipment and in accordance with NEC requirements.
   3. Other methods as required by NEC and as required by special equipment and field conditions.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.

C. Coordinate installation of electrical connections for equipment with installed equipment.

D. Verify electrical loads (voltage, phase, full load amperes, number and point of connections, minimum circuit ampacity, and similar characteristics) for equipment furnished under other divisions, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report variances from electrical characteristics noted on electrical drawings to the A/E before proceeding with rough-in work.

E. Obtain and review equipment submittals and shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.

F. Comply with requirements in Section 260553 for identification of electrical power supply conductor terminations.

### 3.02 STARTERS (CONTROLLERS)

A. Install non-packaged 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.

### 3.03 PROVISIONS FOR MECHANICAL CONTROLS

A. Provide 120 Volt, 20 Amp circuit at locations required and described in Section 230900. Coordinate exact locations prior to installation.

B. Install power metering equipment at panelboards and switchboards furnished by control system subcontractor at locations required and described in Section 230900.

### 3.04 EQUIPMENT SHORT CIRCUIT CURRENT RATING

A. All 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 the available fault current delivered from the electrical system. Coordinate final available fault currents with the contractors providing this equipment.

### 3.05 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 22 and 23 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 Volt 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 Radiant Heating Panels, Baseboard Heaters, Cabinet Heaters, Unit Heaters: | M | M | E | M |
| 8. Electric Duct Heating Coils: | M | M | E | M |
| 9a. Duct Smoke Detectors: | E | M | E | E |
| 9b. Relays and Ancillary Devices Associated with HVAC Unit Shutdown by Duct Smoke Detectors: | E | E | E | E |
| 10. Electric Heat Trace: | M | M | E | M |
| 11. Variable Frequency Drives: | M | M | E | M |

| **Item** | Furnished By: | Installed By: | Power Wiring By: | Control Wiring By: |
|---|---|---|---|---|
| 12. Section 230900 Control Panels: | M | M | E | M |

M = Division 22 and 23, Plumbing and HVAC
E = Division 26, Electrical
For purposes of the above table, responsibility of power and control wiring includes raceways, connections and other components as required for complete installation of wiring system.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes selective demolition of existing electrical work as indicated in the Contract Documents.

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

### 1.02 QUALITY ASSURANCE

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

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 EXISTING CONDITIONS

A. Dust Control: Provide protective measures to minimize transfer of noise, dust, dirt, and refuse to adjacent areas of building. Such measure may include dusttight barriers, temporary walls, portable exhaust fans, vacuum systems, and temporary partitioning.

B. Extent: Keep areas of demolition as clean and orderly as physically possible. Do not allow demolition debris to accumulate. Gather debris and dispose daily. Broom or vacuum-clean work areas on daily basis.

C. Protection: Protect existing equipment, furnishing, and systems with protective coverings. Protect finished surfaces including floors, ceilings, and walls.

### 3.02 DAMAGES

A. Repairs: Promptly repair damage to existing surfaces, equipment, finishes, or adjacent facilities at no cost to the Owner and to the satisfaction of the A/E and the Owner.

### 3.03 DEMOLITION

A. General: Provide demolition work required in existing building for removal of existing electrical equipment, raceways, and conductors and for installation of new electrical equipment, raceways, and conductors. Relocate and modify existing electrical equipment, raceways and conductors as required by general construction alterations and by installation of new electrical equipment, raceways, and conductors in existing building to achieve a complete and functioning installation as defined in the Contract Documents.

B. Extent: Remove and dispose of existing materials indicated in the Contract Documents to be removed.

C. Reuse: Do not reuse existing products unless indicated on the Drawings.

D. Materials to Owner: Deliver items to the Owner’s Representative as indicated in the Contract Documents.

E. Materials to Contractor: Materials other than those reserved by the Owner.

F. Existing Conditions: Comply with requirements in Division 01. Verify specific demolition work and operating conditions to be encountered from on-site review and coordination with the Owner. Maintain service to existing equipment and devices during new construction work as required by construction sequencing/scheduling provisions. In areas adjacent to new construction work, provide temporary services as necessary to meet these conditions. Protect active conductors encountered. Notify the A/E of utilities encountered whose services are not known.

G. Repair of Damages to Underground Utilities: Exact location of existing underground utilities is not definitely known. Should any underground utilities be damaged in excavations, restore such utilities without additional cost to the Owner.

H. Drilling of Concrete: Drill openings through existing concrete with diamond tipped rotary core-drilling equipment or carbide tipped drills.

I. Saw-Cutting of Concrete: Saw cut through existing concrete with diamond tipped or carbide tipped saw blade.

J. Outlet Boxes: Cover existing to remain outlet boxes in walls or ceilings as follows:
   1. Existing with mud ring: Provide blank stainless steel cover plate large enough to cover mud ring
   2. Existing without mud ring: Provide flat mud ring and blank stainless steel cover plate to ensure there are no holes or gaps between the box and the finish surface. Where gaps occur provide the following:
      a. Small gaps between outlet box and finished surface:
         1) Provide an oversized cover plate
      b. Large gaps between outlet box and finished surface:
         1) Provide patching and painting in accordance with Division 09 specifications.
         2) Provide an oversized cover plate

## 3.04 DISPOSAL OF DEMOLISHED MATERIALS

A. Disposal: Remove debris, rubbish, and other materials resulting from demolition operations from building site unless reinstalled or delivered to the Owner as indicated in the Contract Documents. Transport and legally dispose of material off site.

B. Burning: Burning of removed materials is not permitted on project site.

## 3.05 CLEAN-UP AND REPAIR

A. Clean-Up: Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protection and leave interior areas clean.

B. Repair: Repair demolition performed in excess of that required at no additional cost to Owner. Return structures and surfaces to conditions existing prior to commencement of demolition work or as directed by the Owner.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes wire, cable, splices, and terminations for systems 600 Volts and less and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 83, Thermoplastic-Insulated Wires and Cables.
   3. UL 62275, Cable Ties for Electrical Installations

C. Comply with NEC as applicable to construction and installation of electrical wire and cable. Electrical wire and cable UL listed and labeled.

D. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of wire and cable.

E. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of wire and cable.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of wire, cable, and appurtenance.

C. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 PRODUCTS

### 2.01 POWER AND LIGHTING CIRCUITS

A. Factory-fabricated conductors of sizes, ratings, materials and types indicated on the Drawings for each service. Where not indicated, select to comply with project's installation requirements and NEC standards. Comply with the following:
   1. UL 83.
   2. Copper Conductor - Stranded.
   3. Insulation type THHN/THWN-2 dual rated or XHHW-2, 600 Volt for circuits from 115 to 600 Volts.
   4. Use only 90 C insulated conductors based on 75 C ampacity tables of the NEC.

### 2.02 CONTROL AND SIGNAL CIRCUITS

A. Class 1:
   1. UL 83.
   2. Stranded copper conductor.
   3. Insulation type THHN, or THWN, 600 Volt for circuits from 115 to 600 Volts.

B. Class 2 and 3:
   1. Copper conductor, 300 Volt insulation, rated 75 C in dry locations and 60 C in wet locations. Individual conductors twisted together and covered with non-metallic jacket unless otherwise noted on the Drawings.
   2. UL listed for use in air handling ducts and hollow spaces used as ducts and plenums.
   3. Category UTP cabling for electrical control systems:
      a. Cable type per system manufacturer and shop drawings.
      b. Comply with the most current technical characteristics of TIA-568-C standard.
      c. Comply with NFPA 262 CMP (plenum) rated, unless otherwise noted.

### 2.03 PLASTIC CABLE TIES

A. Teflon or nylon, locking type

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 WIRING AND CABLE INSTALLATION, GENERAL

A. Install electric conductors and cables as indicated on the Contract Drawings, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation," and in accordance with recognized industry practices.

B. Coordinate installation work with electrical raceway and equipment installation work for proper interface.

C. Pull cables by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device made through approved swivel connection. Non-metallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop to which pull wire can be attached. Remove insulation from conductors before forming loop. Larger sizes of cable may be pulled by using basket weave pulling grip, if pulling force does not exceed limits recommended by manufacturer. If pulling more than one cable, bind them together with friction tape before applying grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.

D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to conductors limited to 0.008 lbs. per circular mil of conductor cross-section area.

E. Pull in cable from end having the sharpest bend (bend closest to reel). Keep pulling tension to minimum by liberal use of lubricant, turning of reel, and slack feeding of cable into duct entrance. Employ not less than one person at reel and one in vault during this operation.

F. For training of cables: provide 12 times cable diameter minimum bend radius to inner surface of cable.

G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50 percent greater than specified above for training.

H. Apply wire and cable pulling compound recommended by specific cable manufacturer.

I. Seal cable ends unless splicing is done immediately.

J. Support cables in vaults, concrete trenches, and similar locations by cable racks. Secure to rack insulators with nylon cord or self-locking nylon cable ties. Place each cable on separate insulator.

K. Follow manufacturer's instructions for splicing and cable terminations.

L. Provide separate neutral conductor for each circuit serving single phase loads, unless indicated otherwise on the Contract Drawings. Where shared neutrals are indicated for multi-wire branch circuits, provide circuit breaker handle ties per Section 262813.

M. Branch circuit wiring:
   1. Group in separate raceways as indicated on the Contract Drawings. Where branch circuit raceways are not indicated on Contract Drawings, a maximum of three circuits may be installed in the same raceway if each circuit originates from the same panelboard.
   2. GFCI Circuit Breakers: XHHW-2 insulation

## 3.05 WIRING METHODS, GENERAL

A. Install wiring in raceways unless indicated otherwise on the Contract Drawings or authorized by the A/E.

B. Install Wire After:
   1. Interior of building is protected from weather.
   2. Mechanical work likely to injure conductors is completed.
   3. Conduits have been cleaned and moisture removed.

C. Neatly train and lace wiring inside boxes, equipment, and panel boards.

D. Clean raceway system before installing conductors.

E. Use half-lapped synthetic tape if taping is utilized for insulation purposes.

F. Provide conductor support devices as required by NEC in vertical conduit runs.

G. Torque conductor connections and terminations to manufacturer's recommended values.

H. Maintain minimum 12-inch clearance between open cabling and heat sources such as flues, steam pipes, and heating appliances.

**3.06 MINIMUM SIZES**

A. Minimum No. 12 AWG for power and lighting circuits.

B. Minimum No. 14 AWG for control wiring.

C. Review lengths/loads and minimum sizes per project to confirm these minimums are acceptable

D. Power and lighting circuits with home run lengths greater than 100 feet. No. 10 AWG minimum.

E. Power and lighting circuits with home run lengths greater than 150 feet. No. 8 AWG minimum

F. Review lengths/loads and minimum sizes per project to confirm these minimums are acceptable

**3.07 CLASS 2 AND 3 CABLE INSTALLATION**

A. Class 2 and 3 Cable: Install using open cabling support methods at indoor locations where allowed by codes, and where raceways are not required per Contract Drawings or for protection of cabling

**3.08 OPEN CABLING INSTALLATION**

A. Class 2 and 3 cabling: run exposed as "open cabling" above accessible ceilings, accessible ceiling plenums and where exposed in unfinished spaces, unless otherwise noted. Install class 2 and 3 cabling in raceway above hard ceilings, where exposed in finished spaces and where subject to damage.

B. Provide all hanger supports and cable supports for cabling specified by Division 26, 27 and 28. All support structures adhere to the requirements in the National Electrical Code. Comply with requirements in Section 260529 Supporting Devices.

C. Install cable bundles horizontal with a maximum deflection of two inches from the bottom of the cable support.

D. Provide additional cable management products to protect exposed cabling and complete the installation of cabling in a neat professional manner.

E. Maintain 12” clear from mechanical equipment and ductwork, fire protection piping and electrical raceways systems. Where limited space exists for cable routing, cables may cross ducts, piping and conduit systems perpendicular with minimum 4” separation. Maintain separation from all mechanical and electrical equipment, ductwork, piping, conduit, clearance spaces and structure.

F. Maintain proper bend radius of cabling bundles and supports changing pathway direction as to not impact the physical jacket construction of the cabling. Replace cabling that becomes damaged during this transition in its entirety.

G. Follow manufacturer's recommendations for quantity of cables supported in J-hooks and adjustable cable supports. Comply with requirements in Section 260529 Supporting Devices.

H. Observe the applicable requirements and recommended good practices contained within TIA-568-C standard for cabling installation requirements.

I. Protect exposed cables where subject to damage. Provide conduit sleeves with bushings at all wall, ceiling and floor penetrations.

## 3.09 WIRING SPLICES AND TERMINATIONS

A. Splice only in accessible junction boxes.

B. Splices and Taps:
Review with Owner if spring clamp connectors ("Wago" connectors) are acceptable. Typically design/build or prefab use.
1. No. 10 AWG and smaller: Compression-set pressure connectors with insulating covers or screw-on pressure (wire nuts).
2. No. 8 AWG and larger: Compression-set pressure connectors with insulating covers. Split bolt splices and connectors not acceptable.

C. Terminations: Eye-type compression lug when termination is to a bolt or screw terminal.
1. 250 kcmil and larger, two-hole long barrel compression lugs.
2. Smaller than 250 kcmil: Single hole compression lug.

D. Tape un-insulated portions of conductor and connectors with electrical tape to 150 percent of conductor insulation value.

E. Clean wires before installing lugs and connectors.

F. Make splices, taps, and terminations to carry full capacity of conductors without perceptible temperature rise.

G. Leave minimum 8 inches of pigtail at outlet boxes for connection to fixtures and devices. Where wiring is continued to other outlets, splice connection wire in a tap. In no case will continuity through double terminal of device be allowed for either hot or neutral leg of circuit.

H. Insulate ends of spare conductors with electrical tape or wire nut.

I. Terminate control circuit conductors at terminal blocks only.

J. Utilize eye or forked tongue type compression set terminator for conductors No. 12 AWG and smaller when termination is to a bolted or screw set type terminal block or terminal cabinet.

K. Make below grade splices in handholes and vaults watertight with epoxy resin type splicing kits similar to Scotchcast.

## 3.10 FIELD QUALITY CONTROL

A. Test for Wires and Cables in accordance with Section 260810.

B. Test Category 5e UTP cabling as follows:
1. Horizontal cabling: certified to meet or exceed the permanent link performance specifications for Category 5e horizontal cabling tested with a frequency range from 1MHz to 100 MHZ as defined in TIA-568-C.
2. Certifications include the following parameters for each pair of each cable installed:
   a. Building System

b. Cable identification between system devices
c. Date of test
d. Test equipment manufacturer and model number
e. Wire map
    1) Continuity to the remote end.
    2) Shorts between any two or more conductors
    3) Reversed pairs
    4) Split pairs
    5) Transposed pairs
    6) Any other miswiring
f. Length
g. Near-end crosstalk (NEXT)
h. Power sum-near-end crosstalk (PS-NEXT)
i. Return loss (RL)
j. Propagation delay (PD)
k. Delay skew (DS)

3. Test horizontal cabling using a Permanent Link configuration as defined in TIA-568-C.
4. Document test reports with an asterisk (*) or fails, identifying the reason for the test failure and a corrective action plan developed.
5. Re-test the permanent link after corrective action has been completed,.
6. Ensure 100 percent of the horizontal cabling system links pass all tests.

C. Organize test results by building system type and cable identification number. Provide test results including the date and time of when each test was saved in the memory of the tester. Record test results in both PDF and manufacturer software formats and provide in the O&M manuals.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes metal clad (MC) cable for branch circuit systems 600 Volts and less and associated appurtenance.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. ASTM B 3, Standard Specification for Soft or Annealed Copper Wire.
   2. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. NFPA 70, National Electrical Code (NEC).
   4. UL 1569, Standard for Metal-Clad Cable.
   5. UL 1581, Reference Standard for Electrical Wires, Cables, and Flexible Cords.
   6. UL 83, Thermoplastic - Insulated Wires and Cables.
   7. UL 1479, Standard for Fire Tests of Through-Penetration Firestops.
   8. UL 44: Standard for Thermoset-Insulated Wires and Cables
   9. UL 1685: Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
   10. UL 2556, Standard for Safety Wire and Cable Test Methods

C. Comply with NEC as applicable to construction and installation of MC Cable. Cable UL listed and labeled.

D. Comply with applicable portions of NEMA/Insulated Cable Engineers Association Standards pertaining to materials, construction and testing of wire and cable.

E. Comply with applicable portions of ANSI/ASTM and IEEE Standards pertaining to construction of wire and cable.

F. Comply with UL 1569 for Metal Clad Cable. Include UL label and manufacturer’s “E” number.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data for each type of MC Cable and appurtenance.

C. Test Reports:
   1. Field test reports.
   2. UL test report for MC Cable.
   3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 PRODUCTS

### 2.01 METAL CLAD CABLES

A. Manufacturers:
   1. Southwire
   2. AFC Cable Systems, Inc.
   3. Encore

B. Branch Circuits:
   1. Single Circuit and Multi-circuit with color-coded conductors. Comply with requirements in Section 260553.
   2. Conductors: Stranded Copper
   3. Conductor insulation: Heat, flame, moisture resistant dielectric layer manufactured and tested in compliance with UL 83.
      a. Dry locations: THHN/THWN.
      b. Damp and wet locations: THHN/THWN-2
   4. Electrical and Physical Properties of Copper Conductors: Conform to applicable standards referenced above. Soft-annealed copper in compliance with ASTM B 3 or ASTM B 8.
   5. Ground Conductor: Insulated grounding conductors sized in accordance with UL 1569, cabled with circuit conductors and identified in compliance with UL 1569.
   6. Circuit and grounding conductors cabled (twisted) with lay length and covered with polypropylene or polyester assembly tape.
   7. Note: Select either galvanized or aluminum. Aluminum is less expensive and significantly lighter weight but not as strong as galvanized
   8. Armor: galvanized steel over cabled wire assembly with interlock in compliance with UL 1569.MC manufacture color system.
   9. Fittings: Malleable iron/steel, angled saddle type, electro zinc plated inside outside, equipped with nylon insulated throat fittings. Thomas and Betts series 3110 & 3150 series or approved. Direct bearing screw type fittings not acceptable. UL listed and labeled MC connectors manufactured for MC Cable Connectors.
   10. Anti-short bushings: Nylon.

C. Note: This is for outdoor, wet locations or use in concrete only. Typically, not permitted so confirm with owner prior to use.
   1. Jacket: PVC applied over Armor

### 2.02 MC CABLE SUPPORTS

A. Cable Clamps, Straps, and Supports: Steel or malleable iron. Comply with requirements in Section 260529 .

## PART 3 EXECUTION

### 3.01 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.

## 3.02 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 work of this section. Protect exposed cable from damage. Remove cable which proves to have faulty wiring and provide new. Abandoning existing and pulling new not acceptable. Repair, repull, and restrap MC Cable determined by the A/E to be poor installation.

## 3.03 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.

## 3.04 METAL CLAD CABLE INSTALLATION

A. Provide metal clad cables as indicated on the Drawings, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.

A. Install metal clad cables only within room served with direct termination to outlet. Provide conduit and wire from panel to junction box above accessible ceiling within each room, before transition to metal clad cabling.

B. Install cables concealed in walls, and above accessible ceilings in spaces,

C. Route parallel and perpendicular to building planes.

D. Maintain minimum 6-inch clearance between cabling and piping. Maintain 12-inch clearance between cabling and heat sources such as flues, steam pipes, heating and hot water pipes, and heating appliances.

E. Where cabling is run in parallel, group on common supports. Comply with requirements in Section 260529

F. Coordinate installation work with equipment installation work for proper interface.

G. Provide anti-short bushings at cut ends of armor.

H. Install MC Cable After:
   1. Interior of building is protected from weather.
   2. Mechanical work likely to damage cables is completed.

I. Note: The paragraph below is intended for use when you allow MC cable for the entire job including home runs. Delete this paragraph is you only allow MC within a single room. Review lengths/loads and minimum sizes per project to confirm these minimums are acceptable

J. Minimum Sizes:
   1. No.12 AWG minimum for power and lighting circuits.
   2. No. 16 AWG minimum for 0-10V lighting control wiring.
   3. Power and lighting circuits with home run lengths greater than 100 feet. No. 10 AWG minimum.
   4. Power and lighting circuits with home run lengths greater than 150 feet. No. 8 AWG minimum.

K. Splice only in accessible junction boxes.

L. Verify continuity of each branch circuit conductor.

M. Tape un-insulated portions of conductor and connectors with electrical tape to 150 percent of conductor insulation value.

N. Include green wire ground. Jacket shall not serve as grounding means.

O. Cut cable using equipment exclusively designed for such use with adjustable cutting depth or automatic means of armor separation. Seatek, Thomas & Betts, or approved.

P. Insulate ends of spare conductors with electrical tape or wire nut.

Q. Label cable as it enters panel, at junction boxes where homerun cables become branch cable, and at branch terminations using permanent cable markers. Tyton, Burndy, Thomas and Betts or approved.

R. Distance Between Supports: Maximum 6-foot centers and within 6 inches of each outlet, and junction box.

S. Support cables below roof decking to provide minimum 1-1/2” separation from raceway surface to nearest surface of metal roof decking

T. Route cable around structural members.

U. Feeders: Acceptable where indicated in the Contract Drawings.

V. Multi-Circuit Cables: a maximum of three circuits may be installed in a single multi-circuit cable if each circuit originates from the same panelboard. Provide a dedicated neutral for each branch circuit unless indicated otherwise on the Contract Drawings.

W. PVC jacketed cable: Required in wet, damp, and corrosive environments or where indicated on the Contract

## 3.05 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test report in the Operation and Maintenance Manual.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes grounding and bonding systems, 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 Work in this section.

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. IEEE C2, National Electrical Safety Code (NESC).
   2. IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System Part 2: Normal Measurements.
   3. IEEE 837, Standard for Qualifying Permanent Connections Used in Substation Grounding
   4. NFPA 70, National Electrical Code (NEC).
   5. NFPA 780, Standard for the Installation of Lightning Protection Systems
   6. UL 467, Standard for Grounding and Bonding Equipment.
   7. UL486A-486B, Wire Connectors
   8. ANSI C119.4, Electric connectors - connectors to use between Aluminum-to-aluminum or aluminum-to-copper conductors

C. Comply with NEC and IEEE requirements as applicable to electrical grounding and ground fault protection systems.

D. Products UL listed and labeled.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each item and appurtenance.

C. Shop Drawings: Plans showing dimensioned location of grounding system features, including ground rods, ground rings, test wells, grounding electrode system connections, and routing of grounding electrode conductors.

D. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 PRODUCTS

### 2.01 SYSTEM DESCRIPTION

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. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.02 GROUNDING ELECTRODES AND CONDUCTORS

A. Ground Rods: Copper clad steel, 3/4 inch diameter by 10 foot long. Copper-Weld Erico, Burndy, Harger, Thomas & Betts or approved.

B. Bare Ground Conductors: Soft drawn copper. Stranded unless indicated otherwise. Tinned where indicated. Solid for No. 8AWG and smaller. Stranded conductors for No. 6 AWG and larger.

C. Insulated Ground Conductors: Copper with 600 Volt insulation in accordance with Section 260519.

D. Ground Bars: Predrilled rectangular bars of annealed copper, 1/4" inch by 4 inches with holes spaced 1-1/8 inches apart to accommodate lug connections. Length 18 inches unless indicated otherwise. Standoff insulators for wall-mounting.

### 2.03 GROUND CONNECTORS

A. Listed and labeled for applications and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connections: Exothermic-welding kits of type recommended by kit manufacturer for materials being joined and installation conditions. Manufacturer: Cadweld, Thermoweld, Thomas & Betts, or approved.

C. Compression Ground Connectors: Conform to IEEE 837 and UL 467.
   1. Cable-to-Cable Connections: Copper or copper alloy. Approved for direct burial or in concrete applications. Manufacturer: Thomas & Betts EZ-Ground® or approved.
   2. Cable-to-Busbar Connections: Two-hole long barrel compression lug, unless indicated otherwise on Contract Drawings.
   3. Cable-to-Cable Tray Connections: Two-hole long barrel compression lug.

D. Mechanical Ground Connectors: Conform to IEEE 837 and UL 467.
   1. Cable-to-Water Piping Connections: Two-piece silicon bronze with stainless steel bolts. Listed for direct bury.
   2. Split-Bolt Connectors: Not acceptable.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

C. Preparation of Surfaces: Clean contacting surfaces of ground connections to bright metal before connecting.

## 3.03 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. System ground not to exceed maximum 5 ohms meggered resistance.

C. Ground each separately-derived system neutral to nearest building steel.

D. Bond together system neutrals, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, underground metal water piping systems, and gas piping systems.

## 3.04 GROUNDING ELECTRODE AND CONDUCTOR INSTALLATION

A. Equipment Ground Conductor: Install separate, insulated equipment ground conductor in each feeder and branch circuit. Terminate each end on grounding lug, bus, and bushing and to intermediate metallic enclosures.

B. Isolated Ground Conductor: For isolated ground branch circuits and feeders, install insulated isolated ground conductor. Isolated ground conductor is in addition to equipment ground conductor. Terminate each end on isolated ground bus.

C. Connect grounding conductors to motors in accordance with NEC. Remove paint, dirt, and other surface coverings at grounding conductor connection points so that good metal-to-metal contact is made.

D. Bare Grounding Conductors Below Grade:
   1. Minimum 30 inches below grade.
   2. Not in contact with gravel fill or concrete. Provide Schedule 40 PVC sleeve where routing through concrete.
   3. Train neatly around foundations and footings.

E. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4/0 AWG. Bond to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

F. Size main grounding system per NEC. Provide conduit to protect ground wire from damage to an area 6 feet above floor.

G. Conductor to Conductors, Conductor to Steel, and Conductor to Ground Rod: Exothermic-welded type connectors. Cadweld, Thermoweld, Thomas & Betts, or approved.

H. When making bolted connection to aluminum and galvanized structures, apply corrosion-inhibitor to contact surfaces between cable, connector, and surface of structure. Penetrox A or approved.

I. Ground Bars: Install where indicated on Contract Drawings. Install horizontally at 12 inches above finished floor, unless indicated otherwise.

## 3.05 GROUND CONNECTORS

A. Welded Connections:
   1. Provide for underground connections.
   2. Provide for connections to structural steel.
   3. Provide for connections to ground bars where indicated.
   4. Provide full weld between coupling and ground rod at joint.
   5. Connect grounding conductors to ground rods at upper end of rod with end of rod and connection point below finished grade, except provide bolted connections at test wells and as otherwise indicated.
   6. When making connections, wire brush or file point of contact to bare metal surface. Use welding cartridges and molds in accordance with manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and clean joint. Use connectors of specified size for conductors and ground rods. Notify A/E before backfilling ground connections.

B. Ground shields of shielded power and control cable at each splice and termination as recommended by manufacturer.

C. Ground metal sheathing and exposed vertical metal structural elements of building. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, instrument cabinets, raceways, and similar items carrying circuits to these devices.

## 3.06 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810.

B. Testing agency, approved by the Owner and the A/E, shall perform ground resistance testing of system. Perform test by means of fall-of-potential method. Maximum acceptable value 5 ohms.
   1. Testing Instrument: Battery-powered or hand-cranked AC tester.
      a. Indicates ground resistance in ohms from digital decade switches when unit's self-contained meter indicates null condition.
      b. Range: 0.01 to 9990 ohms in 4 overlapping ranges.
      c. Null condition occurs when no current flows through potential electrodes.
      d. Instrument accuracy: Plus 2 percent or greater.
   2. Fall-of-Potential Test:
      a. Connect instrument according to manufacturer's instruction.
      b. Place rod P2 at various locations in line between tested electrode and probe C2 and plot results on graph (distance vs. resistance). Take sufficient readings to yield portion of plotted curve as being constant (rate of resistance change becomes so small with respect to distance as to be insignificant).
   3. Conduct 2 separate tests on opposite sides of grounding grid.
   4. Report failure to obtain specified ground resistance to the A/E.

C. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

D. Include field test reports of grounding system in the Operation and Maintenance Manual.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes conduit and equipment supports, fastening hardware, and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data, rated capacities and accessories for each item and appurtenance.

## PART 2 PRODUCTS

### 2.01 MATERIAL

A. General: Built-up framing for electrical raceway and equipment supporting systems, including but not limited to channel, rod, clamps, and hardware. Comply with requirements in Section 260548 for seismic restraints. Unless design is shown on the Drawings, size for 400 percent of calculated load.

B. Channel: 12 gauge galvanized formed metal with or without pre-drilled holes, Pre-galvanized. Cooper B-Line, Unistrut, Powerstrut, or approved.

C. Beam Clamps, in Pairs, at each Supporting (Structural) Beam: B-line B441-22 and B441-22A; Superstrut U-501 and U-502; Unistrut P2785, P2786, and P1379S, or approved. Submit other manufacturers for approval with evidence proving clamp complies with IBC and ASCE 7-05 for seismic requirements. Submitted proof can consist of letter signed and stamped by a professional engineer licensed in engineering in the state in which the Work is performed.

D. Beam Clamps for Use with Rods: B-Line B751-J4, B751-J6, B751-J9, and B751-J12; Superstrut U-569; Unistrut P2824-6, P2824-9, and P2824-12, or approved. Submit other manufacturers for approval with evidence proving clamp complies with seismic requirements. Submitted proof can consist of letter signed and stamped by a professional engineer licensed in engineering in the state in which the Work is performed.

E. Fittings for Attaching Channel-to-Channel for Built-Up Framing: Unistrut P6028, P6033, P6069, P6290, P6291, P6326, P6331, P6332, P6346, P6358A, P6359, P6381, P6382, P6726A, P6917, P6962, or approved.

F. Connectors for Bracing: Unistrut P6186, P7097, P7098, P7100, P7101, P7108, P7109, P7110, P6546, or approved.

G. Hardware, including Nuts (Locking Type), Bolts, and Set Screws: Corrosion resistant, designed for intended use.

H. 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 made of malleable iron.

I. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

J. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58

K. Hanger Rods: Threaded steel

L. Spring Steel Conduit Clips: Erico K series or approved.

M. MC Cable Support Brackets: Erico MCS Series or approved.

N. Circular Cable Retainer:
   1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
      a. Manufacturer: Erico Caddy, Part No. CAT CR50

O. J-Hooks:
   1. J-hooks shall have a galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
      a. Manufacturer: Erico Caddy or approved:
         1) 1” Dia., Part No. CAT16HP
         2) 1-5/16” Dia., Part No. CAT21HP
         3) 2” Dia., Part No. CAT32HP
         4) Note: The paragraph below is intended for use when you have 100+ cables in a bundle

P. Adjustable Cable Support:
   1. Adjustable cable supports shall be of steel and polyethylene, plenum rated, with unlocking and locking bar allowing additional cables to be added easily after installation.
      a. Manufacturer: Erico Caddy, Part No. CAT425

Q. Outlet Box Support:
   1. Where more than one outlet box is shown on the Contract Drawings, and indicated to be at same elevation, align them exactly on center lines horizontally with wall mounting bracket.
      a. Manufacturer: Cooper B-Line Series BB8 or approved:

## PART 3 EXECUTION

### 3.01 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.

## 3.02 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 work of this section.

## 3.03 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.

## 3.04 SUPPORTING DEVICES INSTALLATION

A. Comply with requirements in Section 260548 for seismic restraints.
   1. Install diagonal bracing for trapeze support systems at 2 right angle planes to brace against:
      a. Horizontal and torsional movement lateral seismic forces.
      b. Vertical (uplift) movement caused by vertical seismic forces.
      c. Horizontal distortions in conduit system caused by wire pulling.

B. Unless otherwise shown on the Contract Drawings, attach connectors to vertical framing members with 2 bolts

C. Install toggle bolts or hollow wall fasteners in hollow masonry, plaster, and gypsum board partitions and walls. Install expansion anchors or preset inserts in solid masonry walls, self-drilling anchors, and expansion anchors on concrete surfaces. Comply with requirements in Section 260548 for seismic anchors.

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:
   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. To Steel: Beam clamps MSS SP-58, Type 19 or 23, complying with MSS SP-69.
   6. To Light Steel: Sheet metal screws.
   7. 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 comply with seismic-restraint strength and anchorage requirements

E. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under nuts.

F. Free Standing Electrical Equipment: Bolt to concrete base with leveling channels. Comply with requirements in Section 260510 for concrete base and Section 260548 for seismic restraints.

G. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

H. Transformer Support: Comply with requirements in Section 262200.

I. Lighting Fixture Supports: Fixture support wires for recessed ceilings, match ceiling support requirements. All fixture supports to comply with requirements in Section 265100 and Section 260548.

J. Open Cabling Support Installation
   1. Provide hanger supports and cable supports for cabling specified in Division 26. All support structures shall adhere to the requirements in the National Electrical Code.
   2. Space cabling supports no further than 4’-0" apart.
   3. Install cabling supports on their own dedicated support system.

K. Raceways:
   1. Single raceway runs: Spacing to comply with requirements of Section 260533
      a. Suspended: support by threaded rod with spring steel conduit clips. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings
      b. Mounted to building structure: single hole pipe straps.
   2. Two or more parallel runs of raceway: Install trapeze support systems with 25 percent space (6 inches minimum) for future conduit runs. Refer to Section 260533 for spacing requirements.
   3. Welding conduit and conduit fittings to structure not acceptable.
   4. Spacing: Space so that fittings are accessible to accommodate pulling or splicing.

L. MC Cable:
   1. Single cable runs mounted to building structure with single hole straps specifically designed for MC cabling. Spacing shall comply with requirements of Section 260521.
   2. Where two or more cables runs are routed in parallel, mount to building structure with MC Cable brackets. Spacing shall comply with requirements of Section 260521.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes conduit, electrical metallic tubing, wireway, surface metal raceway, and associated appurtenances within building perimeter.

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

C. Refer to Section 260543 underground electrical work beyond building perimeter.

### 1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances. Comply with local Utility requirements and standards.

B. Codes and Standards:
1. UL 1, Standard for Flexible Metal Conduit.
2. UL 5, Standard for Surface Metal Raceways and Fittings.
3. UL 6, Standard for Rigid Metal Conduit.
4. UL 360, Standard for Liquid-Tight Flexible Metal Conduit.
5. UL 514B, Standard for Conduit, Tubing, and Cable Fittings.
6. UL 651, Standard for Schedule 40 and 80 Rigid PVC Conduit.
7. UL 651A, Standard for Type EB and A Rigid PVC Conduit and HDPE Conduit.
8. UL 797, Standard for Metallic Tubing – Steel.
9. UL 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
10. UL 1242, Standard for Intermediate Metal Conduit – Steel.
11. UL 2420, Standard for RTRC Conduit and Fittings for underground – Fiberglass
12. UL 2515, Standard for RTRC Conduit and Fittings for above ground - Fiberglass

C. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.

D. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements of raceway systems.

E. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes specified and whose products have been in satisfactory use in similar service for not less than 3 years.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data for each type of raceway system and appurtenance.

## PART 2 PRODUCTS

### 2.01 RIGID METAL CONDUIT (RMC) AND FITTINGS

A. Ferrous Metal Conduit: Steel, UL 6, hot-dip galvanized.

B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

**2.02 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS**

A. Ferrous Metal Conduit: Steel, UL 1242, hot-dip galvanized.

B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

**2.03 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS**

A. Ferrous Metal Conduit: Steel, UL 797, hot-dip galvanized.

B. Fittings: UL 514B, galvanized steel, insulated throat, rain tight compression ring type through 1-1/4 inch, set screw type for 1-1/2 inch and larger. Drive-on type and cast fittings not acceptable.

**2.04 FLEXIBLE METAL CONDUIT AND FITTINGS**

A. Ferrous Metal Conduit: Steel, UL 1, galvanized. UL listed for grounding as available. Aluminum and flexible metallic tubing not acceptable.

B. Fittings: Insulated throat, UL 514B, galvanized steel, UL listed for grounding as available.

**2.05 LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS**

A. Ferrous Metal Conduit: Galvanized with PVC weatherproof cover, UL 360 listed for grounding as available.

B. Fittings: Insulated throat, UL 514B, galvanized steel, UL listed for grounding as available.

**2.06 RIGID NON-METALLIC CONDUIT**

A. PVC Conduit: Schedule 40, UL 651, rigid type unless noted otherwise. UL 651A Type A permitted for underground concrete duct banks.

B. Fittings: UL 651, UL 651A, UL 2420 and UL 2515.
   1. For electric (power) duct, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC) with minimum 48 inch
   2. For telecommunications service provider ducts, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC)
   3. For telecommunications on-site distribution ducts, 90 degree elbows with minimum 36 inch radius factory manufactured rigid steel (RMC).

**2.07 SURFACE METAL RACEWAY**

A. UL 5, sheet metal channel with fitted cover. Type and size as shown on the Drawings.

B. Finish: Enamel. Field paint to match wall color.

C. Fittings, Boxes, and Extension Rings: Designed for use with raceway systems.

D. All raceway and fittings to be supplied by one manufacturer.

E. Manufacturers: Mono-Systems, Wiremold, or approved.

## 2.08 CONDUIT BODIES

A. Conduit bodies cast malleable iron, zinc or cadmium plated with threaded connections. Covers gasketed, blank steel, or cast malleable iron, zinc or cadmium plated, and of same manufacturer as conduit body. Where conduit bodies are used as junction or splice boxes, comply with NEC.

B. Conduit bodies (Smart LB) for telecommunications cables shall be die cast aluminum, gray powder coat paint finish, threaded connections with internal built-in radius. Covers gasketed, die cast aluminum, and of same manufacturer as conduit body. Madison Electric or approved equal.
   1. 1-1/4” Smart LB, Madison Electric, KLB120
   2. 2-1/2” Smart LB, Madison Electric, KLB 250
   3. 4” Smart LB, Madison Electric, KLB400

## 2.09 WIREWAY AND AUXILIARY GUTTER

A. UL 870, lay-in type, with hinged cover but without knockouts.

B. Size: As shown on the Drawings, 4 by 4 inch minimum.

C. Finish: Rust-inhibiting primer coat with manufacturer’s standard enamel finish.

## 2.10 EXPANSION FITTINGS

A. Malleable iron, hot-dip galvanized allowing 4 inches (plus or minus 2 inches) conduit movement.
   1. RGC and IMC Raceway: OZ/Gedney Type AX series, Thomas and Betts Type EJG series or approved
   2. EMT Raceway: OZ/GedneyType TX series, Thomas and Betts Type XJG series or approved.

## 2.11 SEALING FITTINGS

A. Wall Sealing Fittings: At each wall sealing fitting, include conduit seal fitting, OZ/Gedney FSK Series or approved.

B. Raceway Stubups and Stubouts: Conduit seals together with wall sealing fittings. OZ/Gedney CSB Series or approved.

C. For Exterior Wall Penetrations below Grade: Include sealing bushing at interior end of penetrating raceway. Only threaded fittings are permitted in entering raceways ahead of sealing bushing. OZ/Gedney Type CSB or approved.

## 2.12 CONDUIT SUPPORTS

A. Conduit Clamps, Straps, and Supports: Steel or malleable iron. Comply with requirements in Section 260529.

## 2.13 FIRE RATED SEALING COMPOUND

A. Dow Corning 3-548 Silicone RTV Foam or approved.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 RACEWAY SIZING, ARRANGEMENT, AND SUPPORT

A. Unless otherwise shown on the Drawings, size conduit for conductor type installed. Minimum size 3/4 inch.

B. Install conduit to maintain headroom and present neat appearance in unfinished spaces. Install a minimum of 9’-6” above finished floor in spaces unless otherwise indicated on the Contract Drawings.

C. Install conduit concealed in walls, below floors, and above ceiling in spaces, except conduit may be exposed in mechanical rooms, electrical rooms, and similar unfinished spaces. Horizontal conduit installation is not allowed in floor slab unless specifically noted on electrical and structural drawings.

D. Route conduit parallel and perpendicular to building planes.

E. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, heating and hot water pipes, and heating appliances.

F. Brace conduit or conduit supports to prevent distortion of alignment by wire-pulling operations.

G. Where conduit is run in parallel, group on formed channel supports. Comply with requirements in Section 260529.

H. Do not fasten or support with wire or perforated pipe straps. Remove temporary conduit supports used during construction before conductors are pulled.

I. Raceway to be routed around structural members. Structural Engineer to approve proposed modifications of structural elements prior to commencement of work.

### 3.05 RACEWAY INSTALLATION

A. Cut conduit square using a saw or pipe cutter. Deburr cut ends.

B. Bring conduit to shoulder of fittings and couplings and tighten securely.

C. Use conduit hubs for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.

D. Do not use conduit bodies to make sharp changes in direction unless shown on the Drawings.

E. Use hydraulic one-shot conduit bender or factory elbows for bends in 2 inch conduit and larger.

F. Provide plastic bushings on conduit stubs used for transition from conduit to open cable runs.

G. During construction, use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

H. Distance Between Supports:
   1. Threaded Rigid Metal Raceways: Maximum ten foot centers and within 18 inches of each outlet, junction box, and bend.
   2. Electrical Metallic Tubing: Maximum ten foot centers at each bend and within 12 inches of each outlet, junction box, and coupling.
   3. Surface Metal Raceway, Auxiliary Gutter, and Wireway: Maximum 5 foot centers or in accordance with manufacturer's instruction, whichever is less, unless otherwise shown on the Drawings.

I. Provide polyester mule tape with printed footage indicators secured at each end of each empty conduit, except sleeves and nipples. Identify with tags at each end indicating origin and destination of empty conduit. Minimum tensile strength of 1250 pounds for conduits 2-inch and smaller and 2500 pounds for conduits larger than 2-inch.

J. Route conduit through roof inside openings for ductwork where possible. Otherwise, install through roof jack and seal weather tight.

K. Install no more than equivalent or four 90 degree bends between boxes.

L. Avoid moisture traps where possible. Where unavoidable, install junction box with drain fitting at conduit low point.

M. Raceway Installation below Slab on Grade:
   1. Installed a minimum of 2 inches below bottom of slab.
   2. Arrange and slope raceway to drain away from building.
   3. Install insulated grounding bushings at conduits stubbed up or out from underground unless capped for future (spare).
   4. Wipe PVC conduit clean and dry before jointing. Apply full even coat of cement to entire area to be inserted into fitting. Let joint cure for minimum 20 minutes.
   5. Install conduit that stub up through floor at such depth that exposed conduit is vertical and no curved section of elbow is visible.

N. Sealing of Conduit Penetrations:
   1. Exterior Wall Surfaces Above Grade: Seal around penetrations with caulking approved by the A/E. For concrete construction above ground level, cast conduit in wall or core drill wall and hard pack with mixture of equal parts of sand and cement.
   2. Exterior Wall Surfaces Below Grade: Cast conduit into wall (and floor) or use manufactured seal assembly cast in place.
   3. Roofs: Install mopped and flashing roof jack and where conduit penetrates roof membrane.
   4. Fire Rated Construction: Seal penetrations with fire rated sealing compound to maintain fire rating of construction penetrated.

O. Sealing of Raceways: Seal interior of raceways that pass through building roof and through outside walls of building, above or below grade. Seal on end inside building. Use raceway sealing fittings manufactured for purpose sealed with non-hardening, compound-type mastic, specially designed for such service. Pack around wires in raceways.

P. Raceways on exterior surface of building: install only when shown on the Drawings and as approved by the A/E.

Q. Where flexible metal or liquid tight flexible metal conduit is installed, install bonding conductor to insure electrical continuity of raceway. Route bonding jumper inside conduit and terminate at grounding bushing or grounding locknut installed on inside of junction boxes at each side of flexible section. In instances where this method is not feasible (such as when cast boxes with hubs are used or where required by the NEC, route bonding jumper on outside of flexible conduit and terminate in accordance with methods acceptable to the AHJ.

R. Raceway shall not penetrate sheet metal ducts.

S. Branch circuits: install overhead, except circuits serving floorboxes, outdoor circuits or unless indicated otherwise on the Contract Documents.

T. Support raceways below roof decking: provide minimum 1-1/2” separation from raceway surface to nearest surface of metal roof decking.

U. Spare Raceways: Install 6 spare 3/4 inch conduits (capped) from each recessed/flush mounted branch panelboard into ceiling space or mechanical platform if one exists. Extend conduits required distance necessary to reach accessible ceiling space.

V. In finished areas with exposed structure, subject to the approval of the A/E, raceways may be installed exposed. Install raceways as high as possible, provide minimum 1-1/2” separation from raceway surface to nearest surface of metal roof decking, and neatly arranged. Submit shop drawing indicating routing of proposed surface raceways and boxes in finished areas.

W. Service Entrance Feeders: Where raceway for service entrance, install conduit under ground level slab or in 2 inch thick concrete encasement. Coordinate concrete encasement installation with A/E prior to installation to avoid conflicts with other disciplines. Comply with NEC requirements.

## 3.06 SURFACE METAL RACEWAY INSTALLATION

A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.

B. Install insulating bushings and inserts at connections to outlets and corner fittings.

C. Maintain grounding continuity between raceway components for continuous grounding path.

D. Fastener Option: Use manufacturer’s standard clips and straps for installed purpose.

## 3.07 AUXILIARY GUTTER INSTALLATION

A. Bolt auxiliary gutter to steel channels fastened to wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight gutter.

C. Mount rain tight gutter in horizontal position only.

## 3.08 RACEWAY SCHEDULE

A. Rigid Metal Conduit:
   1. Acceptable in all locations except as modified in this section.
   2. Where in contact with earth or concrete, install protective coating consisting of spirally wrapped 20 mil PVC tape with 1/2 inch minimum overlap – 3M Scotchrap Tape 51 or approved - or utilize PVC Coated Rigid Metal Conduit. Completely wrap and tape field joints.
   3. Required for exposed raceways in areas subject to physical damage

B. PVC Coated Rigid Metal Conduit:
   1. Required in corrosive environments or where indicated on the Contract Drawings,

C. Intermediate Metal Conduit:
   1. May be used in lieu of rigid metal conduit unless otherwise prohibited by code or indicated on the Contract Drawings.
   2. Not acceptable for circuits over 600 Volts.

D. Electrical Metallic Tubing:
   1. Acceptable for dry interior locations where not exposed to moisture or physical damage.
   2. Not acceptable for circuits over 600 Volts.

E. Rigid Non-Metallic Conduit:
   1. Acceptable below concrete slab on grade installed a minimum of 2 inches below bottom of slab.
   2. Acceptable within masonry walls.
   3. Not acceptable for exposed raceways extending through floor slab; utilize Rigid Metal Conduit.
   4. Not acceptable for bends 45 degrees and greater unless concrete encased; utilize Rigid Metal Conduit as specified herein, PVC Coated Rigid Metal Conduit or Fiberglass (RTRC). Field bends not acceptable.
   5. Concrete encased where indicated on Contract Drawings or where required by Code or Utility.

F. Flexible Steel Conduit:
   1. For connections to recessed light fixtures and devices installed in suspended ceilings, maximum six foot length.
   2. For connections to motors, transformers and other equipment subject to vibration. Minimum of three foot and maximum of six foot length with 90 degree loop.

G. Liquid-Tight Flexible Metal Conduit.
   1. For pump motors and equipment subject to vibration in damp and wet locations, in areas subject to being washed down, and for machinery where cutting oil is used. Minimum of three foot and maximum of six foot length with 90 degree loop.

H. Surface Metal and Multi-Outlet Raceway: Install where indicated on the Contract Drawings.

I. Auxiliary Gutters and Wireways: Install where indicated on the Contract Drawings and as required in unfinished spaces. Elsewhere as approved by the A/E.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes outlet, junction, and pull boxes and associated appurtenances required to enclose devices, permit pulling conductors, and for wire splices and branches.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NFPA 70, National Electrical Code (NEC).
   3. UL 514A, Metallic Outlet Boxes.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of outlet box and appurtenance.

## PART 2 PRODUCTS

### 2.01 OUTLET BOXES FOR INTERIOR WIRING

A. General: Outlet and pull boxes pressed steel, zinc coated with plaster ring where applicable, minimum 4 inch size.

B. Telecommunications and Audio Visual: Outlet and pull boxes galvanized steel, with plaster ring where applicable, minimum 4-11/16 inch, 3-1/4-inches deep.

C. Surface Metal Raceway: Boxes of same manufacturer and to match raceway. Boxes to accommodate standard devices and device plates.

D. Concrete and Masonry: Boxes for casting in concrete and mounting in masonry walls of type specifically designed for that purpose.

E. Ceiling Outlet Boxes: Galvanized octagonal 4 inch, 1-1/2 inches deep (without fixture stud) and 2-1/8 inch deep (with fixture stud).

F. Sheet Metal Boxes Larger than 12 Inches in any Dimension: Include hinged enclosure.

G. Cut in Outlet Boxes: Retro-Ring 205RAC to position 4" sq. steel junction box in covered wall cavity.

### 2.02 OUTLET BOXES FOR EXTERIOR WIRING

A. General: Weather resistant and rain tight, with appropriate covers, gaskets, and screws.

B. Above Grade: Outlet and junction boxes cast or malleable iron or cast of corrosion resistant alloy compatible with raceway to which they are connected. Pull boxes fabricated of hot dipped galvanized heavy gage steel. Boxes with gasketed covers.

C. Below Grade: Provide underground vaults as specified in Section 260543.

### 2.03 OUTLET BOXES CONTAINING MULTIPLE DEVICES

A. Outlet Boxes Containing Emergency and Normal Devices: Permitted only with steel barriers manufactured especially for purpose of dividing outlet box into 2 completely separate compartments.

B. Outlet Boxes Containing Multiple Devices and Wiring Rated over 150 Volts to Ground and Over 300 Volts Between Conductors: Permitted only with steel barrier manufactured especially for purpose of dividing outlet box into separate compartments for each device having exposed live parts.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 COORDINATION OF OUTLET BOX LOCATIONS

A. Locate as shown on the Drawings and as required to facilitate pulling. Limit number of bends per NEC.

B. Electrical box locations shown on the Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets before roughing in.

C. Locate outlet boxes to allow access. If inaccessible, furnish, arrange, and pay for installation of access doors.

D. Coordinate Work of this section with the Work of other sections and trades to avoid conflicts. Check and verify door swings and locations of built-in cabinets, plumbing, heating, and ventilating equipment.

E. Install outlet boxes of sizes and at locations necessary to serve equipment furnished under this or other divisions of the specifications. Make final connections thereto. Outlet boxes required if equipment is furnished with pigtail for external connection, does not have space to accommodate branch circuit wiring, or requires wire with insulation rating different from branch circuit wiring. Review equipment Shop Drawings for required outlet locations.

F. Where more than one outlet box is shown on the Drawings, and indicated to be at same elevation or one above the other, align them exactly on center lines horizontally or vertically. Relocate outlet boxes which are not so installed (including lighting, receptacle, power, signal, and temperature control outlets) at no additional cost to the Owner.

G. Centered on Built-In Work: In the case of doors, cabinets, recessed or similar features, or where outlet boxes are centered between such features, such as between door jamb and cabinet, make these outlet box locations exact. Relocate outlet boxes which are not centered.

H. Flush mount boxes with front edge of box or plaster ring even with finished surface of wall and ceiling, except those mounted above accessible ceilings and where surface mounting is permitted.

I. Locate to maintain headroom and to present a neat appearance.

J. Route conduit from switch and receptacle boxes in walls vertically to space above ceiling. Install junction box before horizontal run.

K. Offset outlet boxes minimum of one stud horizontal separation between flush boxes mounted on opposite sides of acoustic rated common wall.

L. Install outlet boxes with minimum 6 inch horizontal separation between closest edges of flush boxes mounted on opposite sides of common wall.

M. Ceiling Locations: Locate outlet either at corner joint or in center of a panel, whichever is closer to normal spacing. Locate outlet boxes in same room in same panel locations.

N. Conceal outlet boxes for electric water coolers behind cooler unit housing.

## 3.05 OUTLET BOX INSTALLATION

A. Anchor boxes so they will not shift or rock when devices are operated (including insertion and removal of cord caps).

B. Firmly anchor flush outlet boxes directly or with concealed bracing to studs and joists.

C. Close unused openings.

D. Support boxes independently of conduit except for cast outlet boxes that are connected to 2 rigid metal conduits, both supported within 12 inches of outlet box.

E. Use multiple-gang outlet boxes where 2 or more devices are mounted together. Do not use sectional boxes.

F. Install blank covers or plates over outlet boxes that do not contain devices.

G. In inaccessible ceiling areas, install outlet and junction boxes within 6 inches of recessed luminaire to be accessible through luminaire ceiling openings.

H. Install recessed outlet boxes in finished areas. Secure outlet boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall and adjustable steel channel fasteners for flush ceiling outlet boxes.

I. Install outlet boxes in walls without damaging wall insulation.

J. Seal conduit boxes, telephone boxes, and similar items air tight with acoustical caulk where located in acoustical rated walls that are not fire rated.

K. Install outlet boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for outlet boxes. Use outlet boxes with sufficient depth to permit conduit hubs to be located in masonry void space.

L. Install pull boxes to be accessible after completion of building construction.

## 3.06 ELECTRICAL WORK IN COUNTERBACKS, MILLWORK, AND CASEWORK

A. Install as shown on the Drawings. Furnish templates to other trades for drilling and cutting to ensure accurate location of electrical fixtures (outlets and devices) as verified with the A/E. Install wiring, devices, plates, and connections required by said fixtures.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes floor outlet devices for power and communications and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 514A, Metallic Outlet Boxes.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of outlet device and appurtenance.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Flush Type Outlet Devices: Hubbell, Wiremold, Steel City, or approved.

### 2.02 MULTI-SERVICE RECESSED FLOOR OUTLET DEVICES

A. Four compartment single-gang flush floor boxes.

B. Fully Adjustable Cast Iron: Steel City 665-CI, Wiremold RFB4-CI-1 (Resource RFB) or approved.

C. Fully Adjustable Stamped Steel: Steel City 665-AV2, Wiremold RFB4 (Resource RFB) or approved.

D. Cover: Flush access hatch with carpet trim and wire management blocks. Steel City 665-CST Series, Wiremold FPCTC series, or approved.

### 2.03 LARGE MULTI-SERVICE RECESSED FLOOR OUTLET DEVICES

A. Eight-gang flush floor boxes with optional device mounting brackets.

B. Fully Adjustable on Grade: Wiremold EFB8S-OG or approved.

C. Fully Adjustable Stamped Steel: Wiremold EFB8S or approved.

D. Cover:
   1. Flush access hatch with carpet trim. Wiremold EFB610CT or approved.
   2. Flush access hatch with solid lid. Wiremold EFB610BT or approved.

E. Mounting Bracket:
   1. Four Single-Gang, Wiremold EFB8-MB.
   2. Two Double-Gang, Wiremold EFB8-22GMB.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 FLOOR OUTLET DEVICE INSTALLATION

A. Install and anchor floor outlet devices shown on the Drawings. Coordinate exact location with the A/E.

B. Attach conduits to cast iron housing.

C. Align coverplate over top of housing and tighten screws.

D. Level box and pour concrete.

E. Adjust top surface to level and flush with finished floor.

### 3.05 CARPET FLANGE INSTALLATION

A. Install after final floor covering has been installed.

### 3.06 CORE DRILLING FLOORS

A. Perform coring of floors for installation of poke through devices in a neat workmanlike manner and as recommended by the manufacturer. Patch or replace floor construction and finish damaged by installation of outlet devices to original condition or as directed by the A/E.

B. Review floor construction type with the A/E prior to core drilling. X-ray post tensioned slabs to verify acceptable location of core drill.

C. When core drilling over an occupied floor, make provisions to prevent damage to floor. Repair or replace items damaged at no additional cost to the Owner.

D. Where building construction will not permit core drilling, provide sleeves in floor slab to permit installation of outlet devices. Verify exact locations with the A/E.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Underground electrical work beyond building perimeter including vaults, handholes, direct-buried conduit, ductbanks, and associated appurtenances.

B. Provide, coordinate and obtain approval for underground electrical work for utility systems in accordance with utility company requirements.

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

D. Refer to Section 260533 for work within building perimeter.

E. Refer to Section 260510 for additional earthwork requirements

### 1.02 DEFINITIONS

A. Vault: Underground structure for electrical equipment and wiring.

### 1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances. Comply with local Utility requirements and standards.

B. Codes and Standards:
   1. UL 6, Standard for Rigid Metal Conduit.
   2. UL 651, Standard for Schedule 40 and 80 Rigid PVC Conduit.
   3. UL 651A, Standard for Type EB and A Rigid PVC Conduit and HDPE Conduit.
   4. UL 2420, Standard for RTRC Conduit and Fittings for underground – Fiberglass.
   5. AASHTO M-306, Standard for Drainage, Sewer, Utility and Related Castings.
   6. Electric Utility Requirements.

C. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.

D. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements of underground vaults, conduit and ducts.

E. Manufacturers: Firms regularly engaged in manufacture of vaults, handholes, conduit and ducts of types and sizes specified and whose products have been in satisfactory use in similar service for not less than 3 years.

### 1.04 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data for each type of vault, handhole, conduit, duct and appurtenance.

C. Shop Drawings for vaults: Include plans, elevations, sections, details and accessories, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Cover design and vault frame support rings.

3. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
4. Joint details.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

B. Lift and support precast concrete units only at designated lifting or supporting points.

### 1.06 COORDINATION

A. Coordinate layout and installation of ducts, vaults and handholes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of duct entrances into vaults and handholes with final locations and profiles of ducts as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to vaults and handholes, and as approved by A/E.

## PART 2 PRODUCTS

### 2.01 RIGID METAL CONDUIT (RMC) AND FITTINGS

A. Ferrous Metal Conduit: Steel, UL 6, hot-dip galvanized.

B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

### 2.02 RIGID NON-METALLIC CONDUIT

A. PVC Conduit: Schedule 40, UL 651, rigid type unless indicated otherwise.

B. Fittings: UL 651, UL 651A, UL 2420 and UL 2515.
1. For electric (power) duct, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC).
2. For telecommunications service provider ducts, 90 degree elbows with minimum 48 inch radius factory manufactured rigid steel.
3. For telecommunications on-site distribution ducts, 90 degree elbows with minimum 36 inch radius factory manufactured rigid steel (RMC).

### 2.03 Duct Accessories

A. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.

B. Conduit Fittings at Vaults and Handhole Entrances: End Bells.

### 2.04 PRECAST HANDHOLES

A. Handholes: Precast concrete with open bottom unless indicated otherwise on the Contract Drawings.

B. Rating: Rated for application where installed: AASHTO H-20 highway loading where installed in roadways and drive lanes, medium duty loading in off-street locations that are not subject to high density traffic or light duty pedestrian traffic in walkways not subject to vehicle traffic.

C. Identification: Permanently engrave handhole covers with the system designation. Handhole designations visible from the surface.
   1. Electrical handhole labeled “ELECTRIC”.
   2. Telecommunications handhole labeled “COMMUNICATIONS”.

D. Frame and Cover: Weatherproof cast iron frame. Cast iron cover with on-skid surface and lift or pull slots. Capable of being secured to the body with tamper resistant fasteners.

E. The manufacturer’s name and model number must be permanently indicated to an interior wall face.

F. Acceptable Manufacturers: Oldcastle, Christy, Hanson, Hubbell, or approved.

### 2.05 HANDHOLES OTHER THAN PRECAST

A. Handholes: HDPE with an open bottom unless indicated otherwise on the Contract Drawings.

B. Rating: Rated for light duty: pedestrian traffic. Suitable for landscape areas only.

C. Identification: Permanently engrave handhole covers with the system designation. Handhole designations visible from the surface.
   1. Electrical handhole labeled “ELECTRIC”.
   2. Telecommunication handholes designated “COMMUNICATIONS”.

D. Cover: Weatherproof with non-skid surface, and lift or pull slots. Capable of being secured to the body with tamper resistant fasteners.

E. The manufacturer’s name and model number must be permanently indicated to an interior wall face.

F. Finish: Gray in concrete or paved areas. Green in landscape areas.

G. Acceptable Manufacturers: Oldcastle, Christy, Hanson, Hubbell, or approved

### 2.06 GROUNDING

A. Grounding: Install ground rod and bonding connections, provide as specified in Section 260526 and as indicated herein.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 PREPARATION

A. Field Measurements: Field verify locations of ducts, vaults, and handholes with final arrangement of other utilities, site grading, and surface features as determined in the field prior to commencing work of this section.

B. Coordination: Coordinate elevations of conduit, ducts and duct bank entrances into vaults and handholes, with final locations and profiles of conduit, ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that conduit and duct runs drain away from building to vaults and handholes, and as approved by A/E.

C. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 EARTHWORK**

A. Provide as specified in Section 260510 and as indicated herein.

B. Work with extreme care near existing utilities to avoid damage. Cut the trenches neatly and uniformly.

C. Pitch the trenches uniformly toward vaults and handholes or both ways from high points between vaults for the required duct line drainage. Avoid pitching the ducts towards buildings.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoil, seed, sod, and/or mulch according to Division 32.

E. Cut and patch existing pavement in the path of underground conduit and ducts according to Division 01.

**3.04 RACEWAY INSTALLATION**

A. Install top raceway at depth shown on the Contract Drawings or minimum 24 inches below finished grade, whichever depth is deeper.

B. Install detectable marker tape over underground raceway as specified in Section 260553. Warning marker tap must be 12 inches below finished grade directly above duct bank.

C. Install raceway with minimum slope of 4 inches per 100 feet to drain away from building. Slope ducts from a high point in runs between two vaults to drain in both directions.

D. Duct Entrances to Vaults: Grout end bells into structure walls from both sides to provide watertight entrances.

E. Cut conduit square using a saw or pipe cutter. Deburr cut ends.

F. Bring conduit to shoulder of fittings and couplings and tighten securely.

G. During construction, use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

H. Provide polyester mule tape with printed footage indicators secured at each end of each empty conduit, except sleeves and nipples. Identify with tags at each end indicating origin and destination of empty conduit. Minimum tensile strength of 1250 pounds for conduits 2-inch and smaller and 2500 pounds for conduits larger than 2-inch.

I. Raceway bends between vaults and handholes.
   1. Power: No more than equivalent of three 90 degree bends
   2. Telecommunications: No more than equivalent of two 90 degree bends

J. Underground Raceway Installation:
   1. Install insulated grounding bushings at conduits stubbed up or out from underground unless capped for future (spare).
   2. Wipe PVC conduit clean and dry before jointing. Apply full even coat of cement to entire area to be inserted into fitting. Let joint cure for minimum 20 minutes.
   3. Install conduit that stub up through floor at such depth that exposed conduit is vertical and no curved section of elbow is visible.

K. Do not install conduit on exterior surface of building, except as shown on the Drawings and as approved by the A/E.

## 3.05 RACEWAY SCHEDULE

A. Rigid Metal Conduit:
   1. Acceptable in all locations except as modified in this section.
   2. Where in contact with earth or concrete, install protective coating consisting of spirally wrapped 20 mil PVC tape with 1/2 inch minimum overlap – 3M Scotchrap Tape 51 or approved - or utilize PVC Coated Rigid Metal Conduit. Completely wrap and tape field joints.

B. PVC Coated Rigid Metal Conduit:
   1. Required in corrosive environments or as indicated on the Drawings.

C. Rigid Non-Metallic Conduit:
   1. Acceptable underground with minimum 24 inches of cover.
   2. Not acceptable for raceways extending through concrete; utilize Rigid Metal Conduit or Fiberglass (RTRC).
   3. Not acceptable for bends 45 degrees and greater unless concrete encased; utilize Rigid Metal Conduit as specified herein, PVC Coated Rigid Metal Conduit or Fiberglass (RTRC). Field bends not acceptable.
   4. Concrete encased where indicated on Contract Drawings or where required by Code or Utility.

## 3.06 HANDHOLES INSTALLATION

A. Install precast handholes on a solid ring of base material such as concrete around the outer edge to prevent settlement. The base material shall include openings that allow drainage from the box into the soil. Boxes must be set plumb and elevated slightly above surrounding grade to prevent them from becoming the water collection points. Conduit ends must be sealed to prevent debris from entering the raceway.

## 3.07 FIELD QUALITY CONTROL

A. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Test vault grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526.

### 3.08 Cleaning

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of vaults and handholes, including sump. Remove any foreign material.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes isolation pads, spring isolators, restrained spring isolators, restraint cables, hanger rod stiffeners, anchorage bushings and washers, and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards: NFPA 70, National Electrical Code (NEC).

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation and seismic restraint device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to the AHJ.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

C. Delegated-Design Submittal: For vibration isolation and seismic restraint details indicate to comply with performance requirements and design criteria, including analysis data signed and sealed by professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.
      b. Comply with requirements in other Division 26 sections for equipment mounted outdoors.
   2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
   3. Field fabricated supports.
   4. Seismic Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to structure during seismic events. Indicate association with vibration isolation devices.

c. Preapproval and Evaluation Documentation: By agency acceptable to AHJ, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Welding Certificates.

E. Test Reports:

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

### 1.04 PERFORMANCE REQUIREMENTS

A. General: A single supplier shall furnish isolation mounts, pads, seismic restraints, 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.

C. Seismic Restraints:

1. Design and select restraint devices for ducts, pipes, and equipment to meet seismic requirements defined in IBC and ASCE 7-05. Prepare calculations based on coefficients included on the structural drawings. Refer to the structural drawings for allowable methods and loads.
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.

## PART 2 PRODUCTS

### 2.01 VIBRATION ISOLATORS

A. Manufacturers: Amber/Booth, California Dynamics Corporation, Kinetics Noise Control, Mason Industries, Vibro-Acoustics, Vibration Mountings & Controls, or approved.

B. Isolation Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
2. Minimum Additional Travel: 50 percent of required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4 inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed. Factory-drilled baseplate bonded to 1/4 inch thick neoprene or rubber isolator pad attached to baseplate underside. Adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and AHJ.
3. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.02 SEISMIC RESTRAINT DEVICES

A. Manufacturers: Amber/Booth, California Dynamics Corporation, Cooper B-Line, Hilti, Mason Industries, TOLCO, Unistrut, or approved.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements as defined in reports by an agency acceptable to AHJ.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components minimum 4 times maximum seismic forces to which they will be subjected.

C. Restraint Cables: ASTM A 492 stainless steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service. Include minimum 2 clamping bolts for cable engagement.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene with a flat washer face.

H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of 8 times diameter.

I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to the AHJ.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces. Welding stiffeners to rods not acceptable.

C. Strength of Support and Seismic Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### 3.05 SEISMIC RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
   1. Install restrained isolators on electrical equipment.
   2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic restraint devices using methods approved by agency acceptable to AHJ providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall mounted equipment, arranged to provide resilient media where equipment or equipment mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated on the Drawings, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, and at concrete members.

D. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the A/E if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, and grout has achieved full design strength.
3. Mechanical Anchors: Protect threads from damage during anchor installation. Install sleeve anchors with sleeve fully engaged in structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from bottom of hole and progressing toward surface in such a manner as to avoid introduction of air pockets in adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.

## 3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections and branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

## 3.07 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Obtain the A/E's approval before transmitting test loads to structure. Install temporary load-spreading members.
   2. Test at least 4 of each type and size of installed anchors and fasteners selected by the A/E.
   3. Test to 90 percent of rated proof load of device.
   4. Measure isolator restraint clearance.
   5. Measure isolator deflection.
   6. Verify snubber minimum clearances.
   7. If a device fails test, modify installations of same type and retest until satisfactory results are achieved.

B. Remove and replace malfunctioning units, provide new, and retest as specified above.

C. Prepare test and inspection reports. Include copy of reports in the Operation and Maintenance Manual.

## 3.08 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes nameplates, wire and cable markers, conduit color coding, buried duct marking tape, and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards: NFPA 70, National Electrical Code (NEC).

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Nameplate schedule.

## PART 2 PRODUCTS

### 2.01 IDENTIFICATION MATERIAL

A. Nameplates:
   1. Engraved three-layer laminated plastic.
      a. Normal Power: White letters on black background.
      b. NEC 702 System – Optional Standby Power: White letters on green background.
      c. UPS Power: White letters on blue background.
   2. Panelboards and Switchboards: 1/2 inch high letters to identify equipment designation. 1/4 inch high letters to identify voltage rating and source.
   3. Control Panels and Equipment (Lighting and Receptacle Control): 1/2 inch high letters to identify equipment designation. 1/4 inch high letters to identify source, control panel name and space and zone controlled as designated on the Drawings..
   4. Enclosed Circuit Breakers, Disconnect Switches, Motor Starters: 1/4 inch high letters to identify load served and source.
   5. Transformers: 1/2 inch high letters to identify equipment designation as indicated on the Drawings. 1/4 inch high letters to identify primary and secondary voltages, primary source, and secondary load and location.
   6. Power Monitoring: 1/2 inch high letters to identify meter designation. 1/4 inch high letters to identify metering category.
   7. Automatic Transfer Switches: 1/2 inch high white letters to identify equipment designation, voltage rating, normal source, standby source and load served and location.
   8. Emergency/Standby Power Boxes and Enclosures larger than six inches by six inches. 1/2 inch high letters to identify equipment and source designation.
   9. Service Entrance Equipment: 1/2 inch high letters to identify available fault current.
   10. Digital Control Switches: 1/4 inch engraved letters on push button or cover to identify control zone.
   11. Feeders: 1/4 inch high letters to identify feeder ampacity, phase conductor size and quantity.

B. Adhesive Printed Labels:
   1. Laminated tape – Brother TZe Series 12 mm width tape or equivalent with adhesive back suitable for exterior locations.
      a. Normal Power: Black letters on clear background.
      b. NEC 702 System Emergency Power: Green letters on white background.
      c. UPS Power: Blue Letters on white background.
   2. Switches: 1/4 inch letters to identify load controlled.
   3. Receptacles: 1/4 inch letters to identify panelboard, circuit number and where identified as Dedicated, identify equipment designation as shown on panel schedule
   4. Lighting control devices: 1/4 inch letters to identify lighting control device designation as shown on shop drawings and lighting control program

C. Outlet boxes, junction boxes and pull boxes for emergency system devices and circuits orange in color, both inside and outside.

D. Outlet boxes, junction boxes and pull boxes for fire alarm system devices and conductors: red in color, both inside and outside.

E. Permanent felt marker for junction and pull box.
   1. Normal/Standby/Emergency Power: Black letters indicating circuit notation.
   2. Lighting controls: Black letters indicating “Lighting Control Device” and relays

F. Wire and Cable Markers:
   1. Split sleeve or tubing type. Vinyl impregnated cloth, vinyl, and mylar self-adhesive types not acceptable.
   2. Color code wire in accordance with the coding shown in Decal Detail below. Conductors of power systems in this building (plant) are identified as follows:

| Conductor | 208Y/120 Volt | 480/277 Volt |
|---|---|---|
| A Phase (Left Bus In Panel): | Black | Brown |
| B Phase (Center Bus In Panel): | Red | Orange |
| C Phase (Right Bus In Panel): | Blue | Yellow |
| Neutral: | White | Gray |
| Equipment Ground: | Green | Green |

   3. Where dedicated neutral conductors are provided for single phase circuits, neutral conductor shall have a colored stripe to match the color of the corresponding phase conductor.

G. Phase Identification: Vinyl colored electrical tape.

H. Detectable Buried Duct Marking Tape:
   1. Electrical (Power) Ducts: Six inch wide red tape with words "CAUTION - ELECTRIC LINE BURIED BELOW". 3M Scotch #408 or approved.
   2. Communications/Telephone Ducts: Six inch wide orange tape with the words "CAUTION - TELEPHONE LINE BURIED BELOW". 3M Scotch #411 or approved.

I. Electrical Hazard Marking Tape: Black and yellow striped vinyl 2 inch wide hazard tape, Identi-Tape #VH2BKY or equal.

J. Directory Cards: Directory cards shall consist of heavy cardstock, metallic mounting frames and plastic covers. Mounting frames attached to the back side of panelboard or lighting control panel doors. Directories shall contain typewritten text indicating the circuit breaker or control relay number, type of load served and room number in which each load is located. Unused circuit breakers or control relays designated with “SPARE” written in pencil. Spaces for future circuit breakers left blank. Circuit designations on directory cards shall match the installed conditions with respect to loads and physical arrangement within panelboards.

K. Wiring Color Code Schedules: Prepared using a color printer and laminated between two layers of clear plastic. Schedules shall show color designation for each phase, neutral and ground of each system voltage. Schedule size, 130 mm by 180 mm (5″ by 7″).

L. Arc Flash Hazard Safety Signs: Product safety signs in accordance with ANSI Standard Z535.4 requirements. An electrical hazard (lightning) graphic surrounded by a yellow triangle at the left of each sign. At the top of the right side of the sign, in an orange signal word block, the signal word “Warning” shall appear together with an exclamation mark surrounded by a triangle. Underneath the signal word block, include the message “Arc Flash Hazard” printed on the first line, followed by “Available Fault Current” and “Appropriate PPE Required” on the second line. The sign shall also indicate the flash protection boundary in inches and the incident energy at 460 mm (18″) in cal/cm², in accordance with the requirements of NFPA 70E.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. Description: Install, apply, erect, and perform 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.

B. Nameplates:
   1. Degrease and clean surfaces to receive nameplates.
   2. Install nameplates parallel to equipment lines.
   3. Secure nameplates to equipment fronts using screws or rivets. Adhesives not acceptable.

C. Wire Identification:
   1. Install wire markers on conductors in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

2. Install solid colored jackets for wire sizes smaller than number 8 AWG. Wire sizes larger than number 10 AWG may be taped at both ends and at pull and junction boxes with appropriate colored tape. Color coding tape to completely encircle conductor at least 3 inches wide.

D. Felt Marker Identification: Apply on front of cover in non-finished areas, such as mechanical/electrical rooms, above ceilings, and similar locations, and on back of cover in finished areas.

E. Provide black and yellow striped vinyl 2" wide hazard tape on floor and stencil "Electrical Hazard-Keep Clear" on floor, spaced as to not exceed 4 feet on center to identify code required clearance in front of electrical equipment including switchboards, panelboards, motor control centers, transformers, transfer switches, etc. in unfinished spaces such as electrical and mechanical rooms.

## 3.04 INSTALLATION

A. General:
1. Provide identification for electrical equipment as specified herein.
2. Attach identification in durable manner, suitable to each respective type of identification. Securely fasten nameplates to equipment with two (2) rivets. Wiring color code schedules fastened to equipment with permanent adhesive.

B. Distribution Panelboards and Switchboards: Provide the following nameplates and schedules.
1. Nameplates: Provide for each distribution panelboard and switchboard. Install nameplates on the outside of the equipment enclosures above the incoming line sections.
2. Overcurrent protective device nameplate:. Install nameplates on the outside of the equipment enclosure adjacent to each device.
3. Wiring color code schedule: attach to the exterior of each switchboard and each distribution panelboard. Locate schedules adjacent to the main incoming line sections.
4. Feeder nameplate: attach to the exterior of each switchboard and distribution panelboard to identify the source feeder.

C. Panelboards: Provide the following nameplates and schedules
1. Panelboard nameplate: Provide for each panelboard. On panelboards install nameplates on the outside of panelboard enclosures above doors.
2. Directory cards: Provide in each panelboard. Update room numbers and descriptions to match final owner approved room name/number. Place directory card in holder behind plastic cover.
3. Provide a reduced copy of each panel schedule contained in the Contract Documents, showing actual configuration. Provided panel schedules in addition to the typewritten panelboard directories. Place schedules in directory frame.
4. Provide a wiring color code schedule attached to each panelboard. Install schedules on the inside of panelboard doors.
5. Provide a feeder tag nameplate attached to the exterior of each panelboard to identify the source feeder

D. Control Panels/Equipment:
1. Nameplate: attach to the outside, front of enclosure for each relay panel, control units and control equipment. Nameplate text shall include the relay panel name or space and zone controlled as designated on the Drawings.

E. Provide an arc flash hazard safety sign attached to equipment indicated in power studies. Locate signs so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. On panelboards located in mechanical and electrical rooms, attach the signs on the outside of panelboard enclosures. On all other panelboards, attach the signs on the dead fronts or the back side of the panel doors, so that signs are not visible when panelboard doors are closed.

F. Dry-type Transformers:
   1. Nameplate: attach to the outside, front of each dry-type transformer enclosure. Nameplate text shall include the transformer name as designated on the Drawings.
   2. Feeder tag nameplate: attach to the exterior of each dry-type transformer to identify the source feeder

G. Power Monitoring:
   1. Nameplate: attach on the outside, front of each power meter enclosure. Nameplate text shall include the meter name/number and metering category/load description as designated on the Drawings.

H. Motor Starters:
   1. Provide a nameplate on the outside, front of each starter and variable frequency drive enclosure. Nameplate text shall include the name of load served as designated on the Drawings.

I. Signaling and Communications Systems Cabinets:
   1. Provide a nameplate on the outside of each cabinet above door. Nameplate text shall include the system name as designated on the Drawings and the cabinet function.

J. Disconnect Switches:
   1. Provide a nameplate on the outside front of each disconnect switch enclosure. Nameplate text shall include the name of the load controlled as designated on the Drawings, and also the designation of the equipment that serves as the power source for the circuit that supplies the disconnect.
   2. Provide a feeder tag nameplate attached to the exterior of each disconnect that has overcurrent protection to identify the source feeder

K. Relays and Time Switches:
   1. Provide a nameplate on the outside front of each relay and time switch enclosure. Nameplate text shall include the name of the load controlled as designated on the Drawings.

L. Contactors:
   1. Provide a nameplate on the outside front of each contactor enclosure. Nameplate text shall include the contactor name as designated on the Drawings and the name of the load controlled.

M. Control Switches:
   1. Provide a nameplate for each equipment control switch with a device plate as specified in Section 262726. Nameplate text shall include the name of the load controlled as designated on the Drawings.
   2. Provide a nameplate or printed label on each control switch that does not have a device plate as specified in Section 262726. Verify type with Architect's Consultant. Text shall include the name of the load controlled as designated on the Drawings.

N. Wiring Devices:
   1. Receptacle Labels:
      a. Indicate panelboard and circuit number.
      b. Where noted with equipment description on plan drawing, provide label indicating equipment to be connected as spelled out in panel schedule e.g., refrigerator, microwave, copier, printer, etc.
   2. Provide an engraved printed label for each switch that controls luminaires not within sight of the switch or that controls receptacles. Engraved printed label text shall include the type and location of the load controlled.

O. Junction Boxes and Pull Boxes:
   1. Provide nameplates on the outside of the front cover of junction boxes and pull boxes in finished areas and of junction boxes and pull boxes that are larger than 150 mm by 150 mm (6″ by 6″). Nameplate text shall designate the system for which wiring is to be enclosed in the box. In the case of power system junction boxes or pull boxes, the nameplate text shall also include the panelboard name and circuit number.
   2. Junction boxes and pull boxes 150 mm by 150 mm (6″ by 6″) or smaller in unfinished areas and above accessible ceilings must be color coded by spray painting the outside edges of the box and spray painting the cover with the following colors:

| | |
|---|---|
| 208Y/120 VAC Power: | Unpainted |
| 480Y/277 VAC Power: | Tan |
| Fire Alarm & Detection: | Red |
| Security and Video Surveillance: | Purple |
| Telecommunications: | Blue |
| Intercom/Paging & Clock: | White |
| Television: | Black |
| Audio-video: | Gold |
| NEC 702 Optional Standby System | Green |

   3. After painting, mark the covers of power system junction boxes and pull boxes with the panelboard name and circuit numbers. Marking must be done with a wide-tip, permanent-ink black marker.

P. Outlet Boxes:
   1. Outlet boxes for emergency power and fire alarm circuits must be color coded by spray painting the box inside and outside with the following colors:

| | |
|---|---|
| Fire Alarm & Detection: | Red |
| NEC 702 Optional Standby System | Green |

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes preparation of fault (short-circuit) calculations, protective device coordination study, and arc flash hazard analysis and labeling.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. IEEE C57.109, IEEE Guide for Transformers Through-Fault Current Duration.
   2. IEEE 141, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book).
   3. IEEE 241, IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (IEEE Gray Book).
   4. IEEE 242, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).
   5. IEEE 1584, IEEE Guide for Performing Arc-Flash Hazard Calculations.
   6. NFPA 70, National Electrical Code.
   7. NFPA 70E, Standard for Electrical Safety in the Workplace.
   8. ANSI Z535.4, American National Standard for Product Safety Signs and Labels.

C. Qualifications: Fault calculations, protective device coordination study and arc flash hazard analysis shall be prepared by electrical equipment manufacturer who furnishes incoming service equipment to building or an independent electrical engineer. In either case, calculations and study shall be stamped and signed by a professional engineer licensed in the state in which the Work is performed.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Identification of computer software program used for study.

A. Existing Conditions:
   1. Serving utility information: Contact the utility to get all information upstream of the point of service required to perform the power study. Include the following:
      a. Customer owned primary metered system:
         1) Available Fault Duty at Meter/Point of Service.
         2) Available Fault Duty at upstream substation.
         3) Nearest upstream protective device type/size/settings.
         4) Conductor size/type, number of parallel runs and distance from Point of Service back to nearest upstream protective device.
   2. Existing building distribution system includes the following information:
      a. Switchboards: Nameplate data including manufacturer make/model.
      b. Panelboards: Nameplate data including manufacturer make/model.
      c. Transformers: Nameplate data including Impedance and winding ratio.

d. Feeders: Size, type (material and insulation type), length, number of parallel conductors, conduit type.
e. Overcurrent protection devices:
    1) Circuit Breakers:
        a) Manufacturer make/model and size.
        b) Largest circuit breaker size in each panel/switchboard.
        c) Trip Settings/Ranges.
        d) AIC Rating of lowest rated circuit breaker in each panel/switchboard.
    2) Fuses: Size and type.
f. Generators:
    1) Manufacturer and size.
    2) Transient & Sub-Transient info (xd, x', x", Td, T', T'').
    3) Decrement Curve.

B. Submit study outline.

C. Initial Submittals:
1. One-line diagram with each bus and node having a unique number indicating that fault calculation will be made at that point.
2. Representative one-line diagram of distribution system (with bus numbers as described herein) indicating which devices will be presented in protective device coordination study.

D. Following review and approval of the initial submittals by the A/E, submit final calculations and study in a common bound report.

E. Closeout Submittals:
1. Final report, in the following formats:
    a. Hard copy, bound.
    b. Soft copy, PDF format.
    c. Soft copy, native file(s) in format utilized by computer software program.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this section. Manual calculations are unacceptable.

B. The fault calculations protective device study and arc flash hazard analysis must include complete fault calculations for each proposed and ultimate source combination.

C. Source combinations may include present and future power company supply circuits, large motors, and generators.

D. Drawings and specifications indicate general requirements for electrical equipment being provided. Changes and additions may be suggested by results of study. Submit proposed changes and additions as a part of study.

### 2.02 FAULT (SHORT CIRCUIT) CALCULATIONS

A. Prepare description of calculation methods, assumptions, and base per unit quantities selected.

B. Prepare one-line diagram(s) and source impedance data including X/R ratio and power company system characteristics.

C. Prepare impedance diagrams, typical calculations, tabulations of calculation quantities, and results, conclusions, and recommendations.

D. Prepare calculations of short circuit interrupting and momentary (when applicable) duties for an assumed 3 phase, bolted, fault at medium voltage switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear or switchboard lineup, motor control center, distribution panelboard, branch circuit panelboard, and other significant locations throughout system.

E. Prepare ground fault current calculations for the same system areas including associated zero sequence impedance diagram.

F. Prepare tabulations including fault impedance, X/R ratios, asymmetry factors, motor contributions, short circuit KVA, and symmetrical and asymmetrical fault currents.

## 2.03 PROTECTIVE DEVICE COORDINATION STUDY

A. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

B. Prepare time-current coordination curves graphically indicating proposed. Include upstream and downstream devices associated with each device to illustrate coordination. Include with each curve sheet a complete title and one-line diagram with legend identifying specific portions of system covered by that particular curve sheet.

C. Study shall incorporate all system protective device components.

D. Include detailed description of each protective device identifying its type, function, manufacturer, AIC rating, device tap, time-dial, pick-up, instantaneous, and time-delay settings.

E. Include on curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker and fuse characteristics, pertinent transfer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices.

F. Include, as a minimum, devices down to largest branch circuit and largest feeder circuit breaker in each piece of electrical gear or equipment.

G. Include recommended adjustable settings of overcurrent protective devices including but not limited to the following:
   1. Circuit breakers.
   2. Protective relays.
   3. Ground fault protection.
   4. Zone selective interlocking.

H. Include manufacturing tolerance and damage bands in plotted fuse characteristics.

I. Show transformer full load, 150, 400, and 600 percent current, transformer magnetizing inrush, transformer withstand parameters according to IEEE C57.109, and significant symmetrical or asymmetrical fault current to which device is exposed.

J. Select each primary protective device required for transformer winding configuration shown so that its operating band is within transformer characteristics including point equal to 59 percent of IEEE C57.109 to withstand point for secondary line-to-ground fault protection. Where primary device is not within transformer characteristics, show transformer damage curve.

K. Separate transformer primary protective device characteristic curves by a 16 percent current margin for coordination and protection in event of secondary line-to-line faults. Separate medium voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

L. Prepare complete sets of individual protective device time-current coordination characteristics on transparencies.

### 2.04 ARC FLASH HAZARD ANALYSIS AND LABELING

A. Perform electrical arc flash hazard analysis in accordance with the latest adopted version of NFPA 70E and IEEE 1584 to calculate arc flash protection boundary, working distance, incident energy level and personal protective equipment (PPE) requirements. Arc flash analysis and labeling shall be performed for electrical distribution system equipment including switchboards, panelboards, uninterruptible power supplies, transfer switches, industrial control panels, motor control centers, transformers, enclosed circuit breakers and disconnect switches.

B. Provide arc flash hazard safety signs in accordance with Section 260553, Electrical Identification. Arc flash signs shall include the following information.
   1. Equipment name.
   2. Working distance.
   3. Incident energy level.
   4. Arc flash hazard boundary.
   5. Required PPE level.

C. Where arc flash energy reduction devices are utilized, provide second set of arc flash labels reflecting information when arc flash reduction devices are implemented. Labels shall be visibly different from standard labels for easy identification.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine project overcurrent protective device submittals for compliance with fault calculation study, electrical device coordination and arc flash hazard labeling requirements and other conditions affecting performance.

B. Existing Condition Survey: Field investigate existing conditions to provide the information required for a complete power study from the Point of Service to all new and existing to remain equipment.
   1. Serving utility information: Contact the utility to get all information upstream of the point of service required to perform the power study.

### 3.02 EQUIPMENT SHORT CIRCUIT CURRENT RATING

A. All 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 the available fault current delivered from the electrical system. Coordinate final available fault currents with the contractors providing this equipment.

### 3.03 ADJUSTING

A. After review by the A/E, make revisions to protective device settings to accomplish conformance with approval fault calculations and protective device coordination study. Provide final settings of all adjustable overcurrent devices in accordance with the coordination study.

## 3.04 LABELING

A. Provide arc flash hazard labels on all electrical equipment. Labels shall be located so as to be clearly visible to personnel providing examination, adjustment, servicing or maintenance of the equipment.

## 3.05 DEMONSTRATION

A. Demonstrate to the A/E that correct device settings and ratings have been made. Include settings and ratings on the Record Drawings.

B. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels. Training should include how to use arc flash energy reduction devices to reduce the available arc flash energy at switchboards.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes testing requirements for individual components, equipment, systems, and integration to ensure intended facility operation. Test equipment per manufacturer guidelines and industry standards. Test modes of operation and interlocks and alarm functions. This section presents a guideline of system testing. Provide complete, comprehensive testing in addition to minimum requirements specified in individual sections and in this section.

B. Training: Include comprehensive Owner operation and maintenance training of individual components, equipment, and systems. Training includes normal operation and alternate modes of operations.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. ANSI/NETA ATS 2017, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ANSI/NETA MTS-2015, Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems.
   3. NFPA 70B, Recommended Practice for Electrical Equipment Maintenance.
   4. NFPA 70, National Electrical Code (NEC).

C. Testing Agency: Testing shall be accomplished by an approved testing agency. Retain services of a NETA certified firm or approved. Testing agency shall not be associated with manufacturer of equipment or systems under test.

D. Perform testing and inspections with the assistance of a factory-authorized service representative, where indicated in individual specification sections.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Qualifications: Testing agency qualifications.

C. Testing Plan and Schedule: Detailed plan and schedule of testing, and training for acceptance by the Owner and the A/E prior to initiation of work.

D. Test Procedures: Test procedures and sample test forms.

E. Test Reports: Submit detailed report of testing functions with associated results. Include date of testing and corresponding line item for system tested and individual components. Include testing checklists for each system and device tested. Record for each line item test results that comply with requirements. Record for each line item test results that do not comply with requirements, corrective actions taken to achieve compliance with requirements and retest date and confirmation.

F. Settings of Adjustable Devices: Record as-left set points of all adjustable devices.

G. Include copy of reports in the Operation and Maintenance Manual.

H. Certification: Certification that tests have been completed.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 GENERAL

A. Perform acceptance tests in accordance with manufacturer’s recommendations, NFPA 70 and ANSI/NETA ATS.

B. Report any system, material, or workmanship which is found defective on basis of electrical inspections and tests to the A/E.

C. If test reveals a fault or problem, remove and replace malfunctioning units. Repeat entire test until problem is corrected. Submit additional written test reports.

D. Maintain written record of tests. Upon completion of project, assemble and certify final test report and include in the Operation and Maintenance Manual. Compile field test reports signed by individuals performing the tests.

### 3.05 GENERAL COMPONENT AND EQUIPMENT TESTING REQUIREMENTS

A. Phase Relationship Tests: Check connections to existing and new equipment for proper phase relationship. During such check, disconnect devices which could be damaged by application of voltage or reversed phase rotation.

B. Grounding:
   1. Test each ground electrode system. Comply with requirements in Sections 260526 and 260527.
   2. Visual and Continuity Test: Perform for each of the following ground connections:
      a. Data floor ground system distribution and ground busses.

b. UPS System.
c. PDUs.
d. Equipment ground connections.
e. Cable tray grounding.

C. Feeders:
1. After installation and prior to energization, test cable and wire for continuity of circuitry and for short circuits, Megger circuits of 100 Amp and greater. Correct malfunctions. Submit record of megohmmeter readings to the A/E.
2. Inspect wire and cable for physical damage and proper connection.
3. Inspect ground conductor's installation to ensure ground terminations, jumpers, and devices have solid, mechanical connection.
4. For circuits above 80 Amps, perform torque test for each conductor termination. Torque connections per manufacturer's recommendations and tabulate results.

D. Overcurrent Protective Device Calibration: Perform necessary field settings and adjustments to conform to the coordination study specified in Section 260573.

E. Overcurrent Protective Device Factory Tests: Submit documentation of factory testing of distribution circuit breakers as specified in Section 262813.

F. Switchboards:
1. Perform overcurrent device, conductor, terminations, and thermographic testing described in this section.
2. Inspect equipment for signs of damage.
3. Verify installation per the Drawings.
4. Inspect cabinets for foreign objects. Clean exterior and interior of cabinets from dirt and dust.
5. Check control wiring connections for tightness.
6. Check power wiring connections for tightness.

G. Panelboards:
1. Inspect for physical damage, proper installation, supports, and grounding.
2. Inspect cabinets for foreign objects. Clean exterior and interior of cabinets from dirt and dust.
3. Verify neutrals are grounded only at main or separately derived service point.
4. Check load balance of panelboards for load balance between phases and make adjustments to bring phases within 15 percent of average load.

H. Transformers:
1. Inspect for physical damage, proper installation, supports, and grounding.
2. Inspect enclosure for foreign objects. Clean exterior and interior of enclosure from dirt and dust.
3. Verify grounding system is installed.
4. Verify phase connections.
5. Check power wiring connections for tightness.
6. Check and record secondary voltages and adjust as necessary.

I. Receptacles: Test for open ground, reversed polarity, open hot, open neutral, hot and ground reversed, and hot on neutral.

## 3.06 LIGHTING CONTROLS TESTING

A. Test lighting controls, components and systems in accordance with local codes, manufacturer recommendations.

B. Test each device to confirm operation per manufacturer recommendations and design requirements.

C. Document each component, device and system tested and include “as-left” settings for all adjustable settings. Include a matrix which identifies device, type and location at a minimum.

## 3.07 REPORTS

A. Prepare test reports for each system, equipment and device tested. Include copy of each test report in the Operation and Maintenance Manual. Utilize test forms for systems and equipment tested. Use manufacturer’s standard or other appropriate test forms commensurate with test performed. Test reports shall include the following.
   1. Summary of project.
   2. Description of equipment tested.
   3. Description of test.
   4. Test results including retesting results.
   5. Test dates.
   6. Tester's name.
   7. Witnesses (when required).
   8. Corrective work.
   9. Acceptance criteria.
   10. Conclusions and recommendations.
   11. Appendix including appropriate test forms.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes design, furnish, and install of lighting and plug load control system(s) required to form complete coordinated system(s) ready for operation. Contract Documents indicate minimum scope and performance criteria. It is the responsibility of the lighting controls manufacturer/vendor/contractor to provide a complete system.

B. Digital lighting controls: Stand-alone, Networked energy saving intelligent lighting control system including lighting control panels, network interface modules, emergency lighting transfer devices, as well as digital wall switches, occupancy sensors, daylighting controls, and associated appurtenances.

C. Analog lighting controls: Energy saving lighting control devices including wall switches, occupancy sensors with power supplies, emergency lighting transfer devices, daylighting controls, contactors and associated appurtenances.

D. Receptacle/Plug load controls: Plug load control devices including contactors and relays.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
1. NEMA 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts.
2. NFPA 70, National Electrical Code (NEC).
3. UL 508, Standard for Industrial Control Panels.
4. UL 916, Standard for Energy Management Equipment.
5. UL 917, Standard for Clock Operated Switches.
6. UL 924, Standard for Emergency Lighting and Power Equipment.
7. Washington State Energy Code.

C. Comply with NEC, NEMA, and FCC emission requirements for Class A applications.

D. UL Approvals: Relay panels and accessory devices UL listed and labeled under UL 916. Custom relay panels UL listed and labeled under UL 508. Automatic load control relays UL listed and labeled under UL 924. Branch Circuit Emergency Lighting Transfer Switch UL listed and labeled under UL 1008.

E. Certification: Manufacturer shall certify that products will meet product specifications and local energy codes. If any additional equipment is required to meet coverage patterns and local energy codes, provide additional equipment at no additional cost to the Owner.

### 1.03 DESIGN/PERFORMANCE REQUIREMENTS

A. Design, furnish, and install complete operable lighting control system(s) in accordance with the latest adopted editions of energy code and Owner requirements.

B. Drawings reflect minimum Owner requirements. The Contractor's scope of work shall include but not limited to the following:
   1. Complete lighting control system based on the available architectural, civil, structural, mechanical and electrical drawings.
   2. Wiring systems associated with lighting controls.
   3. Providing additional occupancy sensors, photo sensors, daylight sensors, low voltage switches, relays, dimming modules, UL 924 control devices, control panels, and power supplies associated with lighting controls system.

C. Networked and Stand-Alone digital lighting controls shall accommodate the square-footage coverage requirements for each space controlled as indicated on the lighting zone control plans. Provide relays, control modules, dimming modules, occupancy sensors, switches, daylighting sensors, astronomical timeclocks, networking equipment and cabling, plug/load relays and controllers, contactors and accessories that suit the required lighting and electrical system parameters.

## 1.04 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of lighting control system and components. Include digital cable, analog cable, termination types, wire connectors, manufacturer specific back boxes/supporting equipment.

C. Shop Drawings:
   1. Floor plans showing wall occupancy sensors, light switches, relays, plug/load controllers, contactors, power supplies, dimming modules, network controllers, and mechanical control interface locations. Include typical installation and mounting diagrams for networking dimming and occupancy control devices. Above ceiling devices to be shown on the floor plans.
   2. Reflected ceiling plans showing occupancy sensors, daylighting sensor. Include typical installation and mounting diagrams for occupancy and daylighting control devices.
   3. Detailed point to point wiring diagrams.
   4. System one-line diagram showing panels, number and types of switches and sensors, and building energy management system interface.
   5. Request for engraved switch verbiage
   6. Drawings for each panel showing hardware configuration and numbering.
   7. Panel wiring schedules.
   8. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
   9. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

D. Commissioning/Test Reports:
   1. Field Test Reports.
   2. Commissioning Plan with Test Procedures.

E. Closeout Submittals:
   1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
   2. Operation and Maintenance Manual:
      a. Include approved Shop Drawings and Product Data.

b. Engraved switch identification.
c. Include Sequence of Operation, identifying operation for each room/ space and accent lights.
d. Include manufacturer's maintenance information.
e. Operation and Maintenance Data: Include detailed information on device programming and setup.
f. Include startup and test reports.

### 1.05 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
   2. Relative humidity: Maximum 90 percent, non-condensing.

### 1.06 WARRANTY

A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Digital Lighting Control: Subject to compliance with requirements, Acuity n-Light, Wattstopper DLM, Osram Encelium, Intelligent Lighting Controls (ILC).

B. Analog Lighting Control: Components with single use function, subject to compliance with requirements, Leviton, Sensor Switch, Lutron, Wattstopper, Hubbell.

### 2.02 SYSTEM DESCRIPTION

A. Space Control System: Electrically operated, electrically supervised, lighting control system as described herein. Include control units, power supplies, relays, dimming output control devices, input control devices including occupancy sensors, photo sensors and control switches, wiring, cabling, conduit, fittings, and accessories required for a complete operating system.

B. System Types (indicated in the contract documents):
   1. Digital control: Digital controllers for lighting zones, fixtures and/or plug loads. Provide controllers to match the lighting and plug load control requirements. System, control, and features include:
      a. Stand-alone digital control system: Digital control within a single space to bind room loads to the connected control devices in the space. Control functions are limited to the devices connected to the stand alone digital control system.
         1) Self-configuring digital controller(s) with all digital parameter data programmed into non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
      b. Networked digital control system: Digital control of devices visible through the network and capable of complete system control including scheduling, room device parameter administration, power monitoring, and reporting device status. The network will have a single user interface point to program or administer the system.

c. Digitally addressable control devices:
   1) On/Off control relays.
   2) Dimming control devices: 0-10V, phase dimming.
   3) Plug load control relays.
   4) Tunable control devices.
d. Digital inputs:
   1) Occupancy sensors.
   2) Photo sensors.
   3) On/Off/Scene and dimming control switches.
   4) Partition sensors.
e. Configuration tools: Allows complete configuration and reconfiguration of the Space. Must be able to tune system without the use of ladders.

2. Analog control: Single function analog devices to control lighting fixture and/or plug loads. Provide devices to match the lighting and plug load control requirements indicated in contract documents.
   a. Analog control devices:
      1) Line voltage control devices receive input from analog low voltage control devices and include the following:
         a) On/Off universal voltage power pack.
         b) Plug load control on/off universal voltage power pack.
      2) Low voltage control devices provide inputs to line voltage control devices or directly to light fixtures and include:
         a) Occupancy sensors.
         b) Photo sensors.
         c) Momentary contact On/Off Switches.
         d) Occupancy sensor control switches W/ 0-10V dimming control where indicated.

C. Comply with requirements in Section 260533 for raceways, Section 260519 for conductors and wiring, Section 260534 for outlet boxes, and Section 260529 for supports. System cabling requirements shall meet manufacturer standards.

D. Open cabling methods may be utilized above accessible ceilings. All cabling in exposed areas, above inaccessible ceilings and in walls shall be installed in raceway.

E. Control: The system shall have control devices to perform automatic and/or manual control functions indicated on the drawings and defined below. The control devices shall be capable of being controlled by any system input device type as well as by building control system DDC/BMS and security control panel. The system shall also be capable of providing sequence of operations functions indicated on the drawings.
   1. Occupancy Sensor Control: Provide occupancy sensors for on/off control with manual dimming of light fixtures in as indicated on drawings. Control shall function as vacancy sensors with Manual-ON functionality or occupancy sensors with Automatic–ON functionality.
   2. Dimming Control Requirements: Provide automatic dimming for each light fixture in daylight areas and manual dimming zones as indicated on lighting zone control drawings.
   3. Manual On/Off Control: Provide control devices to turn on/off all light fixtures within manual control zones as indicated in the drawings.

4. Daylighting Control Requirements: Provide daylight-responsive automatic control in all spaces where daylight contribution is available as defined by relevant local building energy code. See lighting control zone drawings for additional information:
   a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylighting zones.
   b. Daytime set points for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with drawings and specifications.
   c. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system shall be designed to turn off electric lighting when daylight is at or above required lighting levels. Daylighting control system shall turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
5. Timeclock Control Requirements: Provide astronomical timeclock for on/off control based on time of day as indicated in drawings.
6. Plug Load control requirements: Provide control devices to energize/de-energize controlled receptacles as indicated in the drawings. Controlled receptacles are non-essential plug loads in spaces as required by the applicable energy code.
7. Egress Lighting Control: Provide dedicated control devices for all egress lights within each control zone indicated in the drawings. Egress light fixtures shall be on anytime the building is occupied. Control of egress light fixture shall be with time of day during business hours, combination manual override switch and occupancy sensors after hours occupancy sensor.

## 2.03 SYSTEM OPERATION

A. Digital Control System shall include the following features:
   1. Occupancy Sensors: Digital wall/ceiling device or digital wall switch.
      a. Calibration and configuration for the following variables:
         1) Sensitivity: 0-100 percent in 10 percent increments.
         2) Time delay: 1-30 minutes in 1 minute increments.
         3) Test mode: Five second time delay.
         4) Detection technology: PIR, Dual Technology activation and/or re-activation.
         5) Walk-through mode.
      b. Programmable control functionality including:
         1) Each sensor may be programmed to control specific loads within a local network.
         2) Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
         3) On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use one of both technologies. Technologies include:
            a) Ultrasonic or Microphonic.
            b) Passive Infrared.
      c. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal Hours (NH) and After Hours (AH) time periods.
      d. Cable or wiring connections as required by the lighting controls systems.
      e. Device Status LEDs including:
         1) PIR detection.
         2) Ultrasonic or Microphonic detection.

3) Configuration mode.

f. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.

g. Manual override of controlled loads.

2. Dimming Control:
   a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
   b. The following dimming attributes may be changed or selected using a network interface or wireless configuration tool:
      1) Establish preset level for each load from 0-100 percent.
      2) Set high and low trim for each load.
      3) Normalize dimming curve for main ambient light fixtures of each space so they dim at the same rate.
   c. Override button(s) for each load provides the following functions:
      1) Press and hold for dimming control (Dim Up).
      2) Press and hold for dimming control (Dim Down).
   d. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
3. Daylight sensors:
   a. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
      1) Closed loop sensors measure the ambient light in the space and control a single lighting zone.
      2) Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
      3) Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone.
4. Plug Load Control:
   a. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
   b. Default operation is Auto-on/Auto-off, based on timeclock signal for building hours of occupancy.
5. Digital Push Button Switches:
   a. Programmable control functionality including:
      1) Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
      2) Individual button function may be configured to Toggle, On only or Off only.
      3) Individual scenes may be locked to prevent unauthorized change.
      4) Ramp rate may be adjusted for each dimmer switch.
      5) Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
      6) Button priority may be configured to any priority level corresponding to system operation allowing local actions to utilize life safety priority.

7) Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

6. Device Status LEDs to indicate:
   a. Data transmission.
   b. Device has power.
   c. Status for each load.
   d. Configuration status.
7. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
   a. Turn on to 100 percent.
   b. Turn off.
   c. Turn on to last level.
8. Each load be configurable to operate in the following sequences based on occupancy:
   a. Auto-on/Auto-off.
   b. 50% Auto-on/50%Manual-on/Auto-off.
   c. Manual-on/Auto-off.
9. Security Control Panel information shall be available for the following objects:
   a. Load status.
   b. Schedule state, normal or after-hours.
   c. Demand Response enable and disable.
   d. Room occupancy status.
   e. Total room lighting and plug loads watts.
   f. Loads and devices indicated in Control Schedule.
10. Security Control Panel override inputs to the Digital Lighting Control system:
    a. Time of day/hours of operation.
    b. Exterior lighting overrides.
    c. Event overrides - include zones indicated on lighting control plans.
    d. Loads and devices indicated in Sequence of operation matrix provided with BMS controls drawings.

B. Analog Control Devices shall include the following features:
   1. Wall Occupancy Switch:
      a. Manual On/Manual Off push button.
      b. Dimmable push buttons with 0-10V dimming where indicated.
      c. The following sequence:
         1) Time delay: 1-30 minutes in 1 minute increments.
         2) Test mode: Five second time delay.
         3) Detection technology: PIR, Dual Technology activation and/or re-activation.
   2. Wall Switch with ceiling occupancy sensor and power packs:
      a. Manufacturers: Sensor Switch, Watt Stopper, Leviton, Hubbell, or approved.
      b. Manual On/Manual Off momentary contact push button.
      c. Dimmable push buttons with 0-10V dimming where indicated.
      d. Sensors capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
      e. Sensors dual technology which use passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound not acceptable.
      f. Coverage of sensors remains constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.

g. Sensors readily accessible with user adjustable settings for time delay and sensitivity.
h. Include bypass manual override on each sensor in event of failure. When bypass is utilized, lighting shall remain on constantly or control shall divert to wall switch until sensor is replaced. Control recessed to prevent tampering.
i. Include LED as continuous visual means of indication to verify that motion is being detected during both testing and normal operation.
j. Include internal additional isolated relay with NORMALLY OPEN, NORMALLY CLOSED, and COMMON outputs for use with HVAC control, data logging, and other control options.
k. The following sequence:
    1) Time delay: 1-30 minutes in 1 minute increments.
    2) Test mode: Five second time delay.
    3) Detection technology: PIR, Dual Technology activation and/or re-activation.
l. Control wiring between sensors and control units shall be Class 2, No. 18 through No. 20 AWG, stranded, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.

## 2.04 POWER REQUIREMENTS

A. Include 277 VAC power for each controller and power supply.

## 2.05 EQUIPMENT

A. Control Panels: Include power supply, relays, network equipment, dry contact inputs, dry contact outputs, 0-10V dimming modules pre-wired in a single NEMA 1 enclosure. If multiple control panels/devices or pieces of equipment are located in a single space/room, provide custom enclosure with voltage barriers to enclose all of the devices and equipment.

B. Room Controllers (controls 8 or fewer outputs in a single enclosure): Include power supply, relays, network equipment, dry contact inputs, dry contact outputs, 0-10V dimming modules pre-wired in a single NEMA 1 enclosure. If multiple controllers/devices or pieces of equipment are located in a single space/room, provide custom enclosure with voltage barriers to enclose all of the devices and equipment.

C. On/Off Control Relays: Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load mounted in lighting control panel.

D. 0-10V Dimming Controller: The 0-10 V output controller compatible with 0-10V dimming driver/ballast and mounted in lighting control panel. 0-10V output shall automatically open upon loss of power to the Controller to assure full light output from the controlled lighting.

E. On/Off/0-10V Dimming Control Module: On/Off and dimming to control one output or load.
    1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load.
    2. Dual Voltage (120/277 VAC, 60 Hz) capable rated for 3A total load used for single light fixture control.

F. Phase Dimming Controllers: Forward phase 120V dimming modules with network communication functionality.

G. Ceiling/Wall Occupancy Sensors: Features include the following:
    1. Finish White. Provide compatible wall plates with decorator opening.
    2. Sensors capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
    3. Detection technology: Dual Technology activation and/or re-activation.
    4. Time delay: 1-30 minutes in 1 minute increments.

5. Test mode: Five second time delay.
6. Coverage of sensors remain constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.
7. Sensors readily accessible with user adjustable settings for time delay and sensitivity.
8. Include bypass manual override on each sensor in event of failure. When bypass is utilized, lighting shall remain on constantly or control shall divert to wall switch until sensor is replaced. Control recessed to prevent tampering.
9. Include LED as continuous visual means of indication to verify that motion is being detected during both testing and normal operation.
10. Include internal additional isolated relay with NORMALLY OPEN, NORMALLY CLOSED, and COMMON outputs for use with HVAC control, data logging, and other control options. Include additional auxiliary module if sensor doesn't have auxiliary contact.
11. Provide additional detection devices as required for the space.
12. Provide sensors that can function at the same mounting height as the light fixtures including but not limited to the following areas:
    a. Ceiling heights less than 12 feet.
    b. Open ceiling areas of two or more stories.
    c. High-bay areas.
    d. Medium-bay areas.
13. Analog Devices with Power Packs shall use power packs capable of automatic on or manual on.

H. Wall Switch Occupancy Sensors:
1. Finish White. Provide compatible wall plates with decorator opening.
2. Capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
3. Detection technology: Dual Technology activation and/or re-activation.
4. Time delay: 1-30 minutes in 1 minute increments.
5. Test mode: Five second time delay.
6. Coverage of sensors remains constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.
7. On/Off push button.
8. Dim up/Dim down push button with 0-10V Dimming.

I. Photo Sensors:
1. Finish: White. Provide compatible wall plates or ceiling plates with decorator opening.
2. Sensor's internal photodiode shall only measure light waves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers. Sensor light level range shall be from 1-6,553 foot-candles (fc).
3. Closed loop digital photo sensors shall include the following additional features:
    a. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
    b. Automatic self-calibration, initiated from the photo sensor, a wireless configuration tool or a PC with appropriate software.
    c. Automatically establishes application-specific set points following self-calibration. For dimming operation a sliding set point control algorithm with separate Day and Night set points shall prevent abrupt ramping of loads.
4. Open loop digital photo sensors shall include the following additional features:

a. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
b. Automatically establishes application-specific set points following manual calibration using a wireless configuration tool or a PC with appropriate software. For dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.

J. Digital Control Switches:
1. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration.
2. Finish: White. Provide compatible wall plates with decorator opening.

K. Plug Load Control: 120 VAC, 60 Hz rated for 20A total load. .
1. Automatic Load Control Relay: UL 20 rating for receptacle control.
a. Digital relay connected to lighting control system provides ON/OFF control of plug loads within a space/zone via a programmable control relay.

L. Timeclocks:
1. Manufacturer: Compatible with Control Panel, Intermatic ET2800C Series Time Switch or equivalent by Tork, Paragon, or approved.
2. Description: Electronic, solid-state programmable type with alphanumeric display, astronomic feature, automatic daylight savings time reset, 100 hour capacity, carry over, two channel unless indicated otherwise, 24 hour and 365 day calendar, skip-a-day, manual HOA override. Appropriate enclosure suitable for installation.
3. Contact Rating: 20 Amp resistive/general purpose, 10 Amp electronic ballast (LED) unless indicated otherwise.

M. Exterior Photo Cell:
1. Manufacturers: Compatible with Lighting Control Panel, Long Life EK4136S Series or equivalent by Tork, Intermatic or approved.
2. Description: Weatherproof, electronic photo diode to operate in temperature range of minus 30 F to plus 140 F. Light level range of 1.5 “on” to 6 foot-candles “off” with manually adjustable level slide for off and on levels. Time delay of 2-5 seconds minimum to minimize false operation. Conduit wired stem mounting. Manually adjustable level slide. Rating of 6 Amps electronic ballast (LED) at rated Voltage. Compatible with lighting control system.

N. Contactors:
1. Manufacturer: Square D 8903 Series or equivalent by ASCO, Eaton/Cutler Hammer, GE, Siemens or approved.
2. Description: Electrically operated and mechanically held type of types, sizes, and ratings as indicated in the Contract Drawings, 30 Amp, 6-pole minimum. Include auxiliary devices and contacts as indicated on the Contract Drawings, two normally-open contacts minimum. Appropriate enclosure listed for installation.
3. Short Circuit Withstand (SCCR) Rating: Equal to or exceeding the available fault current at the upstream panelboard.

O. Network Communication Equipment: System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies. Hardware compatible with lighting controls systems that provides the following functions:
1. Facilitation of global network communication between different areas and control zones.
2. Time-based control of downstream wired and wireless network devices.
3. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.

4. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall automatically detect all networked devices connected to it, including those connected to wired communication bridges.
7. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 Wired connection.

P. Emergency Lighting Control Equipment:
1. Manufacturers: digital lighting control mfg or approved.
2. Equipment:
a. Automatic Load Control Relay: UL 924 listed control relay.
1) Digital relay connected to lighting control system provides ON/OFF control of emergency lighting within a space/zone via a programmable control relay.
2) Relay provides ON/OFF control of emergency lighting within a space/zone by monitoring the status of the normal lighting control switch for the space/zone.
b. Features include:
1) 120/277 Volts, 50/60 Hz, 20 Amp ballast rating.
2) Push to test button.
3) Auxiliary contact for remote test.
4) Auxiliary contact for fire alarm system interface.
5) Monitors a circuit providing normal lighting in the space
c. Fixture mounted automatic load control relay: UL 924 listed control relay factory mounted in light fixture. Refer to Section 265100 for additional requirements.

Q. Network and Security Control Panel Interface Modules:
1. Network Interface Card: Include network interface card for control of lighting control zones by security control panel. Refer to Section 280100 and security control drawings for control system protocol and requirements. Inputs capable of being conveyed to networked panels in order to allow for connection of security control panel at a single relay panel for lighting control zones.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, A/E, Commissioning Agent, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.

B. Review installation procedures and coordination required with related Work and the following:
1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
2. Review the specifications for low voltage control wiring and termination.
3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

4. Review interface with Division 23 Controls including list of BACnet integration points, schedules and responsibilities.
5. Discuss requirements for integration with other trades.

C. Inspect and make notes of job conditions prior to installation:
1. Record minutes of the conference and provide copies to all parties present.
2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.

**3.03 PRE-INSTALLATION TRAINING**

A. Prior to installation, post submittal, the manufacturer shall provide an on-site training session for the contractor. This is a mandatory meeting for the installing contractor to attend and is to be scheduled by the contractor. Notify A/E two weeks prior to meeting date. Manufacturer to provide agenda and Contractor to provide meeting minutes and attendance list.

**3.04 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 work of this section.

C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

**3.05 INSTALLATION**

A. Install system in accordance with the drawings, this section, Sections 260511, 260519, 260553, 262726, applicable codes and manufacturer's recommendations. Install wiring in compliance with NEC for power and non-power limited signaling circuits. Upon completion, certify in writing to the Owner and general contractor that system has been installed in compliance with NEC.

B. Lighting Control Equipment:
1. Room Controllers/Control Panels: Install where indicated on the plans. Provide 277V power supply and circuit as indicated on the plans, if no circuit is indicated circuit with load on relay 1.
2. Emergency Control Equipment: Install equipment next to normal power lighting controls for the space or the following.
a. Ceiling space above controlled light fixtures.
b. Electrical room/closet.
3. On/Off/0-10V Control Modules:
a. Remote Modules: Install remote mounted control modules in accessible location. Where possible mount to junction box connected to first light fixture in the lighting control zone.
b. Centrally located Control Modules: Two or more control modules mounted in a single location, install control units in a single enclosure with voltage barriers.
4. 0-10V Dimming Controllers: Install in room controllers/control panels where possible. Mount in NEMA 1 enclosure above entry doorway into space and in an accessible location where modules are providing control.
5. Phase Dimming Controllers: Install in electrical rooms.

6. Ceiling/Wall Occupancy Sensors: Install where indicated on the drawings and as required to provide complete coverage based on shop drawings layouts.
   a. Open to structure overhead sensors mount at same height as light fixtures.
7. Wall Switches: Mounting height to match switches in Section 260519.
8. Photo Sensors: Mount per manufacturer recommendations in locations indicated on shop drawings.
9. Network Communication Equipment: Install in main electrical room

C. Digital devices: Connect together with manufacturer approved low voltage network wiring.
   1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
   2. Low voltage wiring topology must comply with manufacturer's specifications.
   3. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

D. Test conductors for ground conditions before making final wiring connections. Comply with requirements in Section 260526.

E. Maintain wiring color code throughout installation. Include color code identification in the Operation and Maintenance Manual.

F. Coordinate with appropriate subcontractors for installation of equipment and devices that pertain to other work in the contract.

G. Clean dirt and debris from inside and outside of the equipment after completion of installation.

H. All line voltage connections shall be tagged to indicate circuit and switched legs.

I. Test all devices to ensure proper communication.

J. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

K. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting set points.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.).
   3. Load Parameters (e.g. blink warning, etc.).
   4. Normalized dimming in lighting control system to match dimming curve of each space main ambient light fixtures.

L. Post Start-up Tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy.

M. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

N. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

O. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to controllers.

## 3.06 INTERIOR LIGHT LEVEL SET POINTS

A. Light Levels: Measurements shall be made in accordance with the methods set forth in Section 9.15 of the IES handbook, 10th Edition.
   1. Measure all spaces/areas identified with a light level set points.
   2. Set dimming level of light fixtures so the maximum light output matches the light level set point.
   3. Photo sensors:
      a. Daylight Zones:
         1) Automatic dimming of light fixtures in primary/secondary daylight zones to maintain illumination levels indicated on Contract Drawings.
         2) Automatically turn off light fixtures when daylight illumination exceeds maintained illumination levels.
         3) Light fixture shall dim to driver/ballast lowest rated light output prior to switching off.
      b. Non-Daylight zones:
         1) Automatic dimming of light fixtures in control zones to maintain light level set point indicated on Contract Drawings.

## 3.07 OCCUPANCY SENSOR SETTINGS

A. Ceiling and wall mount occupancy/vacancy sensor time delay settings of 20 minutes except spaces below or indicated otherwise in the drawings:
   1. Classrooms – Shall be adjusted to 15 minutes.
   2. Public/Student Restroom – Shall be adjusted to 15 minutes.
   3. Corridors – Shall be adjusted to 30 minutes.
   4. Offices/Conference Rooms – Shall be adjusted to 15 minutes.
   5. Work/Storage/Custodial Spaces – Shall be adjusted to 5 minutes.
   6. IDF/MDF Rooms – Shall be adjusted to 30 minutes.

## 3.08 EXTERIOR PHOTOCELL INSTALLATION

A. Mount on building roof facing north, away from spill light influence.

B. Set for appropriate on and off foot-candle levels.

## 3.09 EMERGENCY LIGHTING CONTROL EQUIPMENT INSTALLATION

A. Provide emergency lighting control equipment as required to support control requirements indicated in the Drawings.
   1. Install remote mounted control equipment in accessible location. Where possible mount to junction box connected to first light fixture in the lighting control zone.
   2. Emergency Control Equipment: Two or more controllers mounted in a single location, Install all control units in a single enclosure.

B. Light fixture mounted Emergency Control Equipment:
   1. Factory Installed Devices: Verify that installation operates as intended on the Drawings. Perform necessary field adjustments.
   2. Field Installed Devices: Install in lighting fixtures designated if possible else remote mount device in junction box in accessible location.

C. Schedule simulated power outage with the Owner for verification of emergency light fixture operation.

## 3.10 IDENTIFICATION

A. Identify components, power and control wiring according to Division 26 Section "Electrical Identification".

B. Identify controlled circuits in Directory Cards.

C. Provide engraved nameplate to identify time switches and contactors with a unique designation.

D. Provide engraved push buttons on digital switches, confirm switch labels with owner.

E. Provide printed labels on ceiling tiles or grid runners below all above ceiling mounted control devices.

F. Provide printed labels on Control Relays and modules to indicate controlled loads.

## 3.11 CONTRACTOR COMMISSIONING

A. Upon completion of initial contractor self-commissioning, the contractor shall coordinate system commissioning by the manufacturer's factory authorized representative who shall verify the system is complete and fully functional.

B. Provide computer generated documentation on the commissioning of the system with room by room description including:
   1. Sensor parameters, time delays, sensitivities, daylighting set points.
   2. Sequence of operations (e.g. Manual On, Auto OFF, etc.).
   3. Load Parameters (e.g. blink warning, etc.).
   4. Re-commissioning – After 30 days from occupancy, recalibrate occupancy/vacancy sensor time delay settings, occupancy/vacancy sensor sensitivity settings and photo sensor light level settings. Provide detailed report to A/E for review.

## 3.12 COMMISSIONING SUPPORT

A. Factory technician shall be on-site to support the enhanced commissioning process.

## 3.13 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.

B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
   1. Verify Class I and II wiring connections are terminated properly by validating system performance.
   2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
   3. Verify/complete task programming for all switches, dimmers, time clocks, and sensors.
   4. Verify that the control of each space complies with the Sequence of Operation.
   5. Correct any system issues and retest.

C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
   1. Date of test or inspection.
   2. Loads per space, or Fixture Address identification.
   3. Quantity and Type of each device installed.
   4. Reports providing each device's settings.

## 3.14 DEMONSTRATION AND TRAINING

A. Before Substantial Completion, arrange and provide a one-day (8 hour) Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instructions includes:
   1. Confirmation of entire system operation and communication to each device.
   2. Confirmation of operation of individual relays, switches, and sensors.
   3. Confirmation of system Programming, photocell settings, override settings, etc.
   4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.
   5. Develop and provide Powerpoint presentation to recap the video training sessions. Provide screen shot image of every program/function that was explained during the training session.

B. Provide additional one-day (8 hour) site visit for on additional training and site tuning 60-90 days after occupancy.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes dry-type transformers and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. 10 CFR 431.196.a.2, U.S. Department of Energy (DOE) Energy Conservation Standards for low-Voltage Dry-Type Distribution Transformers.
   2. ANSI C57.96, IEEE Guide for Loading Dry-Type Distribution and Power Transformers.
   3. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent Time of Burning Plastics in a Horizontal Position.
   4. NEMA TR1, Transformers, Regulators, and Reactors.
   5. NFPA 70, National Electrical Code (NEC).
   6. UL 506, Standard for Specialty Transformers.
   7. UL 1561, Standard for Dry-Type General Purpose and Power Transformers.

C. Comply with NEC as applicable to installation and construction of electrical power/distribution transformers, with applicable portions of NEMA TR 1, and with applicable ANSI/IEEE standards pertaining to power/distribution transformers.

D. Comply with applicable portions of UL 506. Distribution transformers UL listed and labeled.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of transformer and appurtenance. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated loads, sound level, tap configurations, insulation system type, and rated temperature rise.

C. Shop Drawings: Submit dimensioned drawings of transformer installations, showing layout, mountings and supports, and spatial relationship to proximate walls and equipment.

D. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

### 1.04 STORAGE AND HANDLING

A. Comply with requirements in Section 260510.

B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.

C. Handle transformers using lifting eyes and brackets included for that purpose. Protect units against entrance of rain, sleet, and snow if handled in inclement weather.

## PART 2 PRODUCTS

### 2.01 TRANSFORMERS

A. Manufacturers: Square D, Eaton/Cutler Hammer, or approved.

B. Ratings:
   1. KVA and voltage ratings as shown on the Drawings.
   2. Transformers designed for continuous operation at rated kVA, for 24 hours a day, and 365 days a year operation with normal life expectancy as defined in ANSI C57.96.
   3. Transformer sound levels not to exceed the following ANSI and NEMA levels for self-cooled ratings:
      a. Up to 9 kVA: 40 db.
      b. 10 to 50 kVA: 45 db.
      c. 51 to 150 kVA: 50 db.
      d. 151 to 300 kVA: 55 db.
      e. 301 to 500 kVA: 60 db.
      f. 501 to 700 kVA: 62 db.
      g. 701 to 1000 kVA: 64 db.

C. Construction:
   1. Insulation Systems:
      a. Transformers insulated with 220 C insulation system based upon 150 C rise.
      b. Required performance obtained without exceeding above temperature rise in 40 C maximum ambient.
      c. Insulation materials flame-retardant and not support combustion as defined in ASTM D 635.
   1. Core and Coil Assemblies:
      a. Transformer core constructed with high-grade, non-aging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Maximum magnetic flux densities below saturation point. Transformer core volume shall allow efficient transformer operation at 10 percent above highest tap voltage. Core laminations tightly clamped and compressed. Coils wound of electrical grade copper with continuous wound construction.
      b. On units rated 9 kVA and smaller, core and coil assembly encapsulated in proportioned mixture of resin and aggregate for moisture proof, shock-resistant seal. Core and coil encapsulation system shall minimize sound level. Taps 2 steps below nominal voltage in 5 percent increments.
      c. On units rated 15 kVA and larger, core and coil assembly impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. Taps 2 steps above and 4 steps below nominal voltage in 2.5 percent increments.
      d. Windings and core and coil assembly treated and built to resist effects of dirt and moisture.
      e. Core coil mounted on rubber isolation mounting pads.
      f. Neutral bus sized and configured for minimum 100 percent of secondary full load current. Transformer impedance minimum of 3 and a maximum of 6 percent.

D. Enclosure:
   1. Enclosure heavy gage steel. Transformers equipped with wiring compartment suitable for conduit entry and large enough to allow convenient wiring. Maximum temperature of enclosure not to exceed 90 C. Core of transformer grounded to enclosure.
   2. On units rated 9 kVA and smaller, enclosure construction totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
   3. On units rated 15 kVA and larger, enclosure construction ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings protected against falling dirt.

E. Connections: Unless noted otherwise on the Drawings, 3 phase transformers with 480 Volt delta connected primary and 208Y/120 Volt, 3 phase, 4 wire connected secondary. Single phase transformers 480 Volt primary, 120/240 Volt secondary. Include provisions for external connections by means of terminal board employing lugs compatible external conductors specified in Section 260519. Connections accessible from front and top of cabinet.

F. Finish: Enclosures finished with ANSI 61 color weather-resistant enamel.

G. Accessories: On outdoor units rated 15 kVA and larger, include weather shields over ventilation openings.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 TRANSFORMER INSTALLATION

A. Install transformers as indicated on the Drawings, complying with applicable NEC, NEMA, and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate transformer installation work with electrical raceway, wire, and cable work necessary for proper interface.

C. Connect transformer units to electrical wiring system. Comply with requirements of other Division 26 sections.

D. Grounding: Comply with requirements in Section 260526.

E. Attach transformers to building structure to prevent overturning in event of earthquake. Include attachment nuts with washers and isolation pads. Transformers on floor, wall, or suspended from ceiling as noted on the Drawings. Bolt floor mounted transformers to concrete bases. Comply with requirements in Section 260510 for concrete bases and Section 260548 for seismic restraints. Remove shipping blocks prior to installation.

F. Transformers with enclosures designed for floor mounting that are to be installed suspended shall include trapeze constructed of minimum 2 horizontal structural channels hung from threaded rods attached to structural members or with inserts in structural slab. Channel, rod, and inserts sized for minimum 400 percent load safety factor. Comply with requirements in Section 260548 for seismic restraints.

G. Install transformers mounted directly on wall with rubber-in-shear isolators sized for 400 percent safety factor.

**3.05 CONNECTIONS**

A. 208/120 Volt 3 phase secondary transformers are considered “grounded neutral separately derived systems” and shall be grounded per Section 260526.

B. Install transformer raceway connections with flexible metal raceway. Raceways shall not enter the bottom of a transformer. Comply with requirements in Section 260533.

**3.06 FIELD QUALITY CONTROL**

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

B. Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance. If not possible, remove and provide new units and retest. Perform test in presence of Owner's Representative.

C. Voltage Tap Connection: Connect transformers at “normal” tap. After facility is completely energized, measure secondary voltages at transformers and service switchboard. Submit list to the A/E for evaluation. Reconnect taps as directed by the A/E.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes switchboards, disconnect switches, transformers, panelboards, and associated appurtenances used for service entrance equipment as specified in applicable Division 26 sections and are included as work of this section. Extent of service entrance work is indicated on the Drawings and schedules.

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

C. Consult local utility company relative to costs for line extensions, connections, and similar requirements and include those costs for bringing service to facility in base bid. Confirm location of point of service before bidding.

D. Include labor and materials required to accomplish local utility company metering in accordance with power company standards and requirements.

E. Include concrete pads of size and type required for service transformers. Verify location, size, openings, reinforcing requirements with local utility company before beginning work. Comply with local utility company clearance requirements.

### 1.02 QUALITY ASSURANCE

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

B. Comply with NEC and NEMA standards as applicable to construction and installation of service entrance equipment and accessories. Provide service entrance equipment and accessories which are UL listed and labeled, and equipment marked, "Suitable for use as Service Equipment".

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for service entrance equipment and appurtenances.

C. Shop Drawings: Submit dimensioned layouts of service entrance equipment and spatial relationships to proximate equipment.

D. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 PRODUCTS

### 2.01 SERVICE ENTRANCE EQUIPMENT

A. General: Include service entrance equipment and accessories, of type, sizes, ratings, and electrical characteristics indicated on the Drawings, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, as required for complete installation, and as specified in this section.

### 2.02 OVERCURRENT PROTECTIVE DEVICES

A. Overcurrent Protective Devices: Comply with requirements in Section 262813 and as indicated on the Drawings.

B. Meter Sockets: Include remote meter sockets which comply with requirements of local utility company supplying electrical power to service entrance equipment of building project. Coordinate exact location of remote meter prior to bid and include costs in base bid.

### 2.03 RACEWAYS, WIRES, AND CABLES

A. Raceways: Comply with requirements in Section 260533.

B. Wires and Cables: Comply with requirements in Section 260519.

C. Wall and Floor Seals: Comply with requirements in Section 260533.

### 2.04 SWITCHBOARDS

A. Comply with requirements in Section 262413.

### 2.05 DISCONNECT SWITCHES

A. Comply with requirements in Section 262816.

### 2.06 TRANSFORMERS

A. Comply with requirements in Section 262200.

### 2.07 PANELBOARDS

A. Comply with requirements in Section 262416.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

## 3.04 SERVICE ENTRANCE EQUIPMENT INSTALLATION

A. Install service entrance equipment as indicated on the Drawings, in accordance with manufacturer's written instructions, and with recognized industry practices to ensure that service entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.

B. Coordination with other work, including local utility company wiring necessary to interface installation of service entrance equipment work with other work.

C. Install floor standing service equipment on 4 inch high concrete pad. Comply with requirements in Section 260510.

## 3.05 GROUNDING

A. Install grounding and bonding connections for service entrance equipment and conductors. Comply with requirements in Section 260526.

## 3.06 ADJUST AND CLEAN

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred enclosure surfaces to match original finishes.

## 3.07 FIELD QUALITY CONTROL

A. Upon completion of installation of service entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Repair malfunctioning units on site, then retest to demonstrate compliance. If not possible to repair on site, remove and provide new units and retest. Include copy of field test reports in the Operation and Maintenance Manual.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes free standing dead front type low-voltage service entrance, distribution and commercial metering switchboards and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards: Design, manufacture and test low voltage switchboards and components in accordance with the following standards:
   1. NEMA PB 2, Deadfront Distribution Switchboards.
   2. NFPA 70, National Electrical Code (NEC).
   3. UL 891, Standard for Dead-Front Switchboards.

C. Manufacturer Qualifications:
   1. Provide assembly and circuit breakers within assembly by same manufacturer.
   2. Provide ISO 9000, 9001, or 9002 certified equipment.
   3. Manufacturer of equipment has produced similar electrical equipment for minimum period of 5 years. When requested by the A/E, submit list of installations with similar equipment demonstrating compliance with this requirement.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each item and appurtenance as follows:
   1. Component list.
   2. Master nameplate schedule.
   3. Assembly Ratings Including:
      a. Short circuit rating.
      b. Voltage.
      c. Continuous current.
   4. Major Component Ratings Including:
      a. Voltage.
      b. Continuous current.
      c. Interrupting ratings.
   5. Cable termination sizes and types.

C. Shop Drawings: Submit for each item as follows:
   1. Front view elevation.
   2. Plan view.
   3. Top view.
   4. Section.
   5. Shipping splits.

6. Assembly data.
7. Wiring diagrams.
8. Single line schematic diagram.
9. Conduit entry/exit locations.
10. Access requirements if not all front accessible.

D. Seismic Qualification Data: Certificates, for switchboards, 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. Test Reports:
1. Field test reports.
2. Factory test reports.
3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS:

A. Switchboards: Square D, Eaton/Cutler Hammer, or approved.

### 2.02 GENERAL:

A. Disconnecting and overcurrent protective devices as indicated on the Contract Drawings and as specified herein.

B. Entire assembly front accessible with main lugs or main device as shown on the Drawings. Rear accessible only allowed where space is indicated on Contract Drawings.

C. Nominal Voltage Rating: As indicated on Contract Drawings.

D. Amperage Rating: As indicated on Contract Drawings.

E. Short Circuit Withstand Rating: Braced to withstand short circuit rating indicated on Contract Drawings; minimum 65,000 Amps symmetrical.

F. Short Circuit Interrupting Rating: Fully-rated for available fault current indicated on Contract Drawings. Refer to Section 262813 for additional requirements.

G. Bus Bars: Silver-plated copper. Bus sizing based on NEMA standard temperature rise criteria of 65 C over 40 C ambient (outside enclosure).
1. Horizontal Bus Bars: Fully-rated for switchboard ampacity entire length. Mounted with phases arranged in same vertical plane. Provide for future extensions from both ends.
2. Neutral bus: Full capacity, unless indicated otherwise, installed entire length of switchboard.
3. Ground bus: Minimum 1/4 inch by 2 inches installed entire length of switchboard and secured to each vertical section structure.

H. Enclosure – Indoor: Steel, NEMA 1. Finish: Exterior and interior steel surfaces of switchboard cleaned and furnished with rust-inhibiting phosphatized coating. Color and finish ANSI 61 light gray. Include pullbox on top of switchboard, where indicated on Contract Drawings or where approved.

I. Barriers: Compartmentalized construction.
   1. Bus isolation barriers arranged to isolate line bus from load bus at each main circuit breaker. Extend section barriers between main circuit breakers to the rear of the section.

J. Control Accessories and Wiring: Type SIS, bundled and secured with nylon ties. Insulated locking spade terminals for control connections except where saddle type terminals are integral to device.
   1. Connect current transformer secondary leads to accessible short circuit terminal blocks before connecting to other devices.
   2. Provide terminal blocks with suitable numbering strips for groups of control wires leaving switchboard.
   3. Provide wire markers at each end of control wiring.
   4. Provide necessary fuse blocks and terminal blocks.
   5. Mark control components mounted within assembly, such as fuse blocks, relays, pushbuttons, switches, and similar components for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

K. Terminations: Compression lugs suitable for copper and aluminum cable rated for 75 C. Size for conductors as indicated on the Contract Drawings.

## 2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. General: Fusible switches or circuit breakers as indicated on Contract Drawings.

B. Spaces for future disconnecting and overcurrent protective devices as indicated. Include bus extensions and ancillary devices to allow for future device without additional modifications.

C. Short circuit rating: Fully rated.

D. Circuit breakers: Per Section 262813.
   1. Circuit breakers 1200 Amps and larger: Individually-mounted, fixed molded-case circuit breakers.
   2. Circuit breakers smaller than 1200 Amps: Group-mounted, fixed, molded-case circuit breakers.

E. Bolted Pressure Switches:
   1. Main protective devices bolted pressure contact type. UL listed and labeled.
   2. Include fusible switches with Class L fuse clips. Switch contact interrupting capacity 12 times continuous rating of switch.
   3. Fuse access door mechanically interlocked with operating handle and with provisions for padlocking switch in open position.
   4. Switch with stored energy dead front operating mechanism compressed and released by operating handle for quick positive switching action independent of speed of operating handle.
   5. Switches manually operated or electrically tripped as indicated on the Contract Drawings. Electrically tripped switches designed to be closed only after opening spring has been charged, ready for electrical opening by solenoid or manual opening by mechanical pushbutton.

6. Include electrically tripped switch(es) with the following accessories where indicated on the Drawings: Ground fault protection including test panel, single phase protection to open switch(es) upon loss of any phase from source, blown fuse protection to open switch upon blowing of one or more of fuses.

F. Fusible Switches:
   1. Quick-make, quick-break.
   2. Switches with safety cover interlocks to prevent opening cover with switch in "ON" position or prevent placing switch in "ON" position with cover open. Include defeater for authorized personnel. Handles with provisions for padlocking and labels to indicate "ON" and "OFF" positions. Front cover doors padlockable in closed position. Fusible switches 30 through 600 Amp frames furnished with rejection Class "R" or "T" type fuse clips unless otherwise scheduled.
   3. Fusible switches 30 through 600 Amp frames furnished with rejection Class "R" or "T" type fuse clips unless otherwise scheduled.
   4. Fusible switches sized 800 through 1200 Amps furnished with Class L fuse clips. Include fusible switches with Class L fuse clips. Switch contact interrupting capacity 12 times continuous rating of switch.
   5. Fusible switches sized 400 through 1200 Amps designed to accommodate UL listed shunt trip. Where shown on the Drawings, furnish the following accessories: UL listed 120 Volt AC shunt trip, zero sequence ground protection system including test panel, ground fault relay with separate time and current pick-up adjustments.

G. Phase Failure Protection: General Electric NBV-11-AA or approved.
   1. Include on bolted pressure switches, fusible switches and where indicated. Include relay with adjustable time delay to operate shunt trip or capacitor operated trip to open switch upon malfunction.

H. Fuses: Per Section 262813.

**2.01 ELECTRONIC POWER MONITORING**

A. General: Integral microprocessor-based digital power monitoring system, wiring and appurtenances.

B. Power Monitoring at Switchboard Main: Eaton/Cutler Hammer XPERT 1000 or equivalent with local display.

C. Power Monitoring at Feeders, where indicated: Eaton/Cutler Hammer DP-4000 or equivalent, with local display.

D. Controls and Networking: Provide with factory-wired CTs, PTs, power supplies, control wiring and ancillary devices. Configure for Mod-Bus interface with mechanical controls system.

**2.02 SERVICE ENTRANCE RATED SWITCHBOARDS:**

A. Service-entrance listed and labeled.

B. Where switchboard is utility-fed, utility metering compartment fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

C. Refer to Section 262410 for additional requirements.

### 2.03 IDENTIFICATION

A. Nameplates:
   1. Comply with requirements in Section 260553. .
   2. Include the item, circuit number, frame amp size and appropriate trip rating as appropriate for the following:
      a. Instruments
      b. Overcurrent protective devices
      c. Disconnection device for the entire assembly.

B. Arc-Flash Warning Labels: Comply with requirements of Section 260553 and Section 260573. Provide for each compartment.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 SWITCHBOARD INSTALLATION

A. Install on concrete housekeeping pad. Anchor to structure. Comply with requirements in Section 260510 for concrete bases and Section 260548 for seismic restraints.

### 3.05 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

### 3.06 TRAINING

A. Comply with requirements in Section 260500.

B. Perform training session for Owner's representative for 1 workday at jobsite location determined by the Owner.

C. Conduct training session by a manufacturer's qualified representative. Provide training program including instruction on operation of assembly, circuit breakers, fused switches, meters, and major components within assembly.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes panelboards for lighting and appliances, distribution circuits, and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. NEMA PB-1, Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
   2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. NEMA FU 1 – Low Voltage Cartridge Fuses.
   4. NFPA 70, National Electrical Code (NEC).
   5. UL 90 – Enclosed and Dead-front Switches.
   6. UL 248 – Low Voltage Fuses.

C. Units UL listed and labeled. Comply with NEC as applicable to panelboards and cabinets. Comply with requirements in NEMA 1 and NEMA 250.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data:
   1. Submit manufacturer's technical product data, installation instructions, maintenance data, and general recommendations for each type of panelboard and appurtenance.
   2. Include dimensioned drawings of panelboards and enclosures showing scaled layouts of enclosures and required individual panelboard devices, including circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, accessories, and similar items.

C. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

### 1.04 SPARE MATERIALS

A. Deliver 6 keys for panelboard enclosures to the Owner.

## PART 2 PRODUCTS

### 2.01 PANELBOARDS

A. Manufacturers: Square D, Eaton/Cutler Hammer, or approved.

B. General:
   1. Except as otherwise indicated on the Drawings, panelboards, enclosures and ancillary components of types, sizes, and ratings indicated. Include number of unit panelboard devices for complete installation. Include "spaces" with hardware to receive breaker or switch of size indicated. Include CU/AL rated lugs of size to accommodate conductors shown on the Drawings and specified in Section 260519.
   2. Include separate ground busbar for panels supplying isolated ground circuits.
   3. Include feed through or double lugs with amperage equal to incoming feeder amperage unless indicated larger on the Drawings.

C. Short Circuit Interrupting Rating: Fully-rated for available fault current indicated on Contract Drawings. Refer to Section 262813 for additional requirements.

D. Lighting and Appliance Panelboards: Dead-front safety type with switching and protective devices in quantities, ratings, types, and arrangement indicated on the Drawings. Include bolt-on thermal magnetic type branch breakers. For multiple breakers, include common trip handle. Include copper bus bars, full-sized neutral bus, ground bus, and isolated ground bus as required.

E. Service and Power Distribution Panelboards: Dead-front safety type with switching and protective devices in quantities, ratings, types and with arrangement indicated on the Drawings. Include copper bus bars, full-sized neutral bus, and ground bus. Include fusible or circuit breaker branch and main devices indicated on the Drawings. Comply with requirements in Section 262813 for overcurrent protective devices.

F. Panelboard Enclosures:
   1. Flush or surface as indicated on the Drawings. Tight closing doors without play when latched. Where 2 cabinets are located adjacent to each other in finished areas, include matching trim of same height.
   2. Include lock for each cabinet door. Electrical distribution equipment locks common keyed.
   3. Door within door – Fasten panelboard front with machine screws. Provide continuous piano hinge on right side of outer door with door latches/locks on left side. Provide second door over dead front with continuous piano hinge on right side with door latches/locks on left side.
   4. Factory prime coat finish for cabinets located in finished areas. Where cabinets are located in unfinished areas, standard lacquer or enamel finish, gray or blue-gray color acceptable for factory finish coat.

G. Identification: Comply with requirements in Section 260553.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

## 3.03 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.

## 3.04 PANELBOARD INSTALLATION

A. Install panelboards and enclosures where indicated on the Drawings in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's “Standard of Installation”, and in compliance with recognized industry practices to ensure products fulfill requirements.

B. Secure in place with top of cabinet at 6’-0”, unless otherwise noted on the Drawings. Top of cabinet and trim level. Anchor cabinets directly or with concealed bracing to building structure. When panels are not located in or directly on a wall, provide support frame of formed steel channel anchored to floor and ceiling structure. Interior components not installed until structure is totally enclosed. Where panels are mounted adjacent to each other, top edges at same height.

C. Bolt floor standing distribution panelboards to concrete base. Comply with requirements in Section 260510 for concrete bases and Section 260548 for seismic restraints.

## 3.05 CIRCUIT INDEX

A. For each branch circuit panelboard, prepare typewritten index listing each circuit in panelboard by number with load designation. Install within a transparent protective cover inside cabinet door. Listing shall match circuit breaker arrangements, typically with odd numbers on left and even numbers on right. Room numbers used shall be final room numbers used in building as verified with the Owner and not room numbers indicated on the Drawings.

## 3.06 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes wall switches, receptacles, device plates, box covers, and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. Federal Specification W-C-596, Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
   2. Federal Specification W-S-896, Switch, Toggle.
   3. NEMA WD 1, General Color Requirements for Wiring Devices.
   4. NFPA 70, National Electrical Code (NEC).
   5. UL 498, Standard for Attachment Plugs and Receptacles.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of wiring device and appurtenance.

C. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 PRODUCTS

### 2.01 WALL SWITCHES

A. Manufacturers: Leviton, Bryant Electric, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.

B. Finish: White.

C. Wall Switches for Lighting Circuits: NEMA WD 1. General use snap switch with colored toggle handle rated 20 Amps and 120/277 Volts AC. Switch with back and side wired screw type terminals. Units specification grade.
   1. Single-Pole Toggle Switch: Leviton Model 1221-2.
   2. Double-Pole Toggle Switch: Leviton Model 1222-2.
   3. Three-Way Toggle Switch: Leviton Model 1223-2.
   4. Four-Way Toggle Switch: Leviton Model 1224-2.

D. Key Type Switches: Rating same as for wall switches:
   1. Single-Pole Key Switch: Leviton Model 1221-2L.

2. Double-Pole Key Switch: Leviton Model 1222-2L.
3. Three-Way Key Switch: Leviton Model 1223-2L.
4. Four-Way Key Switch: Leviton Model 1224-2L.

E. Pilot Light Type: Red pilot handle. Handle lighted when switch is ON. Rating same as for wall switches. Leviton Model 1221-PLR (120V)/1221-7PR (277V).

F. Lighted Handle Type: White pilot handle. Handle illuminated when switch is OFF. Rating same as for wall switches. Leviton Model 1221-LHW (120V)/1221-7LW (277V).

G. Momentary Contact Line Voltage Switches: Single pole, double throw, 3-wire, normally open. Rating same as for wall switches. Leviton Model 1257.

H. Weatherproof: Switches mounted in a cast metal box with gasketed, weatherproof device plate.

**2.02 LED WALL DIMMERS**

A. Manufacturers: Leviton, Lutron, Bryant Electric, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.
1. Architectural Slide Dimmers:
a. Leviton Model IP710-LF

B. Finish: White.

C. Voltage: 120 Volts.

D. Power Rating: Match load shown on the Drawings. 1200 Watts @ 120V and 1500 Watts @ 277V minimum.

E. Accessory Wall Switch: Match dimmer appearance.

**2.03 LOW VOLTAGE CONTROL**

A. Manufacturer: General Electric, Square-D, Cutler Hammer, Siemens, or approved.
1. Relays: General Electric Type RR-7.
2. Switches: General Electric Type RTS-5.
3. Transformers: General Electric Type RT1 and RT2.
4. Rectifiers: General Electric Type RA16.
5. Device Plates: As specified in Article “Device Plates”.
6. Finish: White.

B. Wire: Copper conductor for low voltage control purpose furnished by supplier of low voltage relays and switches.

**2.04 RECEPTACLES**

A. Manufacturers: Leviton, Bryant Electric, Crouse Hinds, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.

B. Finish: White.

C. Convenience and Straight-Blade Receptacles: NEMA WD 1. Units specification grade.

D. Tamper Resistant Receptacle Configuration: (20A-125V NEMA 5-20R) straight blade with grounding type with, back and side wired screw type terminals.

1. Duplex Receptacle: Leviton Model 5362-SG.
2. USB Charger/Duplex Receptacle: Leviton Model T5832.
3. Controlled Receptacle: Leviton Model 5362-2P.
4. GFCI Receptacles: Duplex convenience receptacle with integral ground fault circuit interrupter. Units feed-through type for downstream device protection. Leviton Model G5362-WT.

E. Controlled Receptacle:
1. Finish: Green
2. Leviton Model 5362-2PN.
3. Split Wire: Leviton Model 5362-1PN
4. GFCI: Leviton Model 308-G5362-2TN

F. Weather Resistant Receptacles: Receptacles mounted in a cast steel box with gasketed, weatherproof device plate. Leviton GFWT2.

G. Specific Receptacle Configuration: NEMA WD 1. Type as indicated on the Drawings, with black plastic face.

**2.05 DEVICE PLATES**

A. Manufacturers: Bryant Electric, Hubbell, Leviton, Pass and Seymour, or approved. Bryant Electric and Leviton model numbers are listed.

B. Plates in Finished Areas: Type 302 non-magnetic stainless steel except as noted below:
1. Wall plates for isolated ground receptacles to be with 1/4 inch specially engraved black letters “COMPUTER ONLY”.
2. Wall plates for emergency receptacles with 1/4 inch red letters “EMERGENCY”. Leviton 84003-E40.
3. Wall plates for dedicated receptacles with 1/4 inch specially engraved black letters “DEDICATED”.
4. Wall plates for receptacles protected by a GFCI circuit breaker or feed through GFCI receptacle with 1/4 inch specially engraved black letters “GFCI PROTECTED”. Leviton 84003-G40.
5. Wall plates for receptacles other than NEMA 5-20R with 1/4 inch specially engraved black letters which show ampere rating, voltage, and phase.

C. Plates on Surface Mounted Boxes: Sized to fit box without extending over sides of box.

D. Cast Metal Plates: Cast metal box. Steel plates with steel boxes and copper-free aluminum with aluminum boxes. Stainless steel screws.

E. Raised Sheet Steel Plates: 1/2 inch high zinc or cad-plated covers with surface mounted sheet steel boxes.

F. Weather Resistant Cover Plate:
1. While In-Use Cover: Cast metal with hinged gasketed device covers. Leviton IUM1V-GY unless otherwise noted.
2. Not In-Use Cover: Cast metal with hinged gasketed device covers. Leviton WM1V-GY, only where noted on contract drawings.

G. Finish of Attachment Screws: Match that of its respective device plate.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 WIRING DEVICE INSTALLATION

A. Install wiring devices in clean electrical boxes, free from excess building materials, dirt, and debris.

B. Install jumbo size plates for outlets in masonry walls.

C. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

D. Install devices and wall plates flush and level.

E. Fasten each device to outlet box at wall surface to bring receptacle flush with plate or for switch handle the proper distance through plate.

### 3.05 ORIENTATION

A. Install switches vertical with handle operating vertically, up position "ON". Install center at 44 inches above finished floor unless noted otherwise on the Drawings.

B. Install receptacles vertical with ground slot up centered at 18 inches above finished floor and 6 inches above counters.

C. Install exterior receptacles vertical with ground slot up centered at 18 inches above finished grade.

### 3.06 RECEPTACLE GROUNDING

A. Install bare bonding wire between receptacle grounding terminal and box. Plaster ear screws connecting frame to box not acceptable for grounding.

### 3.07 HANDICAPPED ACCESS

A. Comply with requirements of Washington State Handicapped Access Code.

### 3.08 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

B. Prior to energizing circuitry, test wiring devices for electrical continuity and polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes overcurrent protective devices for operation at 600 Volts and below, including circuit breakers and fuses as individual components in separate enclosures and for installation as integral components of switchboards and panelboards and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards: NFPA 70, National Electrical Code (NEC).

C. Comply with NEMA and ANSI standards as applicable to construction and installation of overcurrent protective devices.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.

C. Shop Drawings: Include layouts of circuit breakers with spatial relationships to proximate equipment.

D. Closeout Submittals:
   1. Written confirmation that all circuit breaker settings were adjusted to match the power studies final report.

E. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

### 1.04 EXTRA MATERIALS

A. Fuses: For each type and rating, furnish additional fuses amounting to 1 unit for every 5 units installed, but not less than 2 units of each size and type.

B. Spare Fuse Cabinet: Provide one, sized to house spare fuses provided under this contract plus 25% additional space for future.

C. Electronic Trip Unit Test Set: Furnish one set, including associated software, capable of testing each circuit breaker type.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

A. Circuit Breakers: Square D, Eaton/Cutler Hammer, or approved. Circuit breaker manufacturer shall be same as panelboard and switchboard manufacturer when installed therein.

B. Fusible Circuit Breakers: Bussmann Mfg. Co.

C. Fuses: Bussmann Mfg. Co. or Mersen Electrical Power. No substitutions. Fuses shall be by one manufacturer.

### 2.02 CIRCUIT BREAKERS

A. General:
1. UL 489 fixed mounted molded case type with unless indicated otherwise.
2. Overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication.
3. Common trip for two and three pole circuit breakers. Handle ties, manufactured by circuit breaker manufacturer, permitted for multi-wire branch circuits on approval of samples.
4. Trip ratings imprinted on handle or visible through deadfront cover.
5. Constructed for mounting and operating in any physical position and calibrated for operation in ambient temperature up to 40 C.
6. Mechanical screw type removable connector lugs, AL/CU rated, to accommodate conductors specified. Rated for 75 C conductors for 60 Amp and larger circuit breakers.
7. Amperage and Voltage as indicated.
8. Short circuit rating: RMS interrupting rating as indicated. Minimum 10,000 AIC rating at 120, 208 and 240 Volts. Minimum 14,000 AIC rating at 277 and 480 Volts.
9. Ground Fault Interrupter (GFI) circuit breakers: Equipped with integral ground fault interrupter set to trip on ground fault of thirty milliamps or greater.
10. Ground Fault Circuit Interrupter (GFCI) circuit breakers: Equipped with integral Class A ground fault circuit interrupter set to trip on ground fault of six milliamps or greater.
11. Arc Fault Circuit Interrupter (AFCI) where indicated.
12. Switching rated for 120 Volt and 277 Volt lighting branch circuits.
13. HACR rating where serving air conditioning and refrigeration equipment.
14. Current limiting, utilizing non-fuse type current limiting, where indicated.
15. Tandem-mounted circuit breakers not acceptable.
16. Minimum Frame Size: To match trip rating, unless indicated otherwise.
17. Keyed Interlocks: Externally-mounted and arranged to prohibit interlocked circuit breaker operation, except in a specified sequence. Include mountings and hardware. Provide nameplates at each keyed interlock indicating interlocked circuit breaker and sequence of operation.
18. Zone-Selective Interlocking: Integral with ground fault trip unit for interlocking ground fault protection function.
19. Arc Energy Reduction: Provide energy-reducing maintenance switch with local status indicator for use as a temporary arc-flash incident energy-reduction device during maintenance activities. Provide for each circuit breaker with a frame size 1200 Amps and larger and as indicated.
    a. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.

b. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
c. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
d. Provide dry relay contacts on each switch for annunciation of the switch position.

**2.03 TRIP UNITS**

A. General:
1. Thermal magnetic unless indicated otherwise.
2. Electronic Trip Unit: Required for circuit breakers:
a. Sized 400 Amps and larger on 480 Volt systems.
b. Sized 800 Amps and larger on systems 250 Volts and lower.
c. Sized 100 Amps and larger serving emergency and legally-required standby systems and equipment.
d. Power circuit breakers.
e. Insulated case circuit breakers.
f. Where indicated or specified.
g. Where required by the Selective Coordination Study.

B. Thermal Magnetic Trip Unit: Adjustable magnetic trip setting for sizes 250 Amps and larger.

C. Electronic Trip Unit: Field-replaceable rating plug. RMS sensing Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:
1. Programmable functions independent of each other in both action and adjustment.
2. Adjustable settings:
a. Instantaneous trip; long and short-time time adjustments; long and short-time pickup adjustments.
b. Where ground fault protection indicated, ground fault pickup level, time delay and $I^2t$ response.
c. Built-in test points for testing the long time, short time, delay, instantaneous, and ground fault functions of the circuit breaker.
3. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

**2.04 FUSES**

A. General:
1. Fuses of type, sizes, ratings, and electrical characteristics of single manufacturer.
2. Fuses labeled UL Class L, UL Class R, current limiting, rated for up to 200,000 Amps.

B. Where fuses are shown on the Drawings feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing. Adjust fuse size and type to comply with manufacturer's recommendation.

C. Main Service, Feeder and Branch Circuit Fuses:
1. For fuse ratings over 600 Amps: UL Class L (KRP-C or A4BY).
2. For fuse ratings up to 600 Amps: UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R).
3. Feeder or branch circuit directly feeding motors, transformers, and other inductive load: UL RK5 time delay (FRN-R, FRS-R or TR-R or TRS-R).
4. Other Branch Circuits: UL Class RK1, (KTN-R, KTS-R or A2K-R, A6K-R).

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 CIRCUIT BREAKERS

A. Install in panelboards, switchboards and enclosures, in accordance with the manufacturer's recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards.

B. Install handle ties for multiwire branch circuits per Section 260519.

C. Device Settings: Adjust in accordance with the Electrical Power Studies report from Section 260573, including but not limited to the following:
   1. Circuit Breakers.
   2. Zone selective interlocking.

### 3.05 FUSES

A. Install fuses in switches, panelboards, switchboards and enclosures. Install fuses so current rating is visible from front when cover is open.

B. Do not install until equipment is ready to be energized.

C. Coordinate with equipment furnished by others for proper fuse type and size.

D. For motor and equipment circuits, fuse sizes shown on the Contract Drawings are for general guidance only. Size fuses in accordance with fuse manufacturer’s recommendation for given motor nameplate ampere rating. Test operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) for nuisance free tripping. Adjust fuse size for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times.

### 3.06 FIELD QUALITY CONTROL

A. Test circuit breakers as specified in Section 260810.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes disconnect switches, enclosed circuit breakers and associated appurtenances.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 98, Enclosed and Dead-Front Switches.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of equipment and appurtenance. Include equipment characteristics such as ratings, enclosure type, dimensions and weight.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

A. Disconnect Switches and Enclosed Circuit Breakers: Square D, Eaton/Cutler Hammer, or approved.

### 2.02 GENERAL

A. Ratings: Voltage, Amperage and horsepower rating suitable for circuit and equipment controlled. Service entrance rated where indicated or required.

B. Enclosures: Surface-mounted.
   1. NEMA Type 1, in general.
   2. NEMA Type 3R where exposed to moisture and where shown on the Drawings.

C. Accessories:
   1. Padlockable in "OFF" position.
   2. Labeled "ON"/"OFF" position.
   3. Ground lug.
   4. Neutral lug where applicable.
   5. Other accessories as indicated.

D. Nameplates: Per Section 260553.

### 2.03 DISCONNECT SWITCHES

A. General: Heavy duty, UL 98, horsepower rated with external handle.

B. Interlock: Defeatable door interlock that prevent door from opening when operating handle is in "ON" position.

C. Fusible or non-fusible as indicated. Fuse rejection clips where Class R fuses are specified.

D. Quick-make, quick-break mechanism. Visible blades.

### 2.04 ENCLOSED CIRCUIT BREAKERS

A. Circuit Breaker: Thermal magnetic circuit breaker per Section 262813. One form "C" auxiliary contact activated when circuit breaker open.

A. Short Circuit Interrupting Rating: Fully-rated for available fault current indicated; 25,000 Amps symmetrical minimum.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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. Comply with applicable requirements of NEC, NEMA and NECA standards, and with recognized industry practice. Where these may be in conflict, the more stringent requirements govern.

B. Install where indicated on the Contract Drawings and where required. Mount independent of equipment served; do not attach to equipment served.

C. Coordinate installation work with electrical raceway, wire, and cable work as necessary for proper interface. Comply with requirements in Section 260533.

D. Install within sight of equipment or controller served.

E. Where locations are not shown on Contract Drawings, locate on wall adjacent to equipment being served or on formed steel channel frame at face of equipment. Coordinate location to maintain equipment clearances.

### 3.04 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes motor controls for electrical motor driven equipment and associated appurtenances. Refer to Section 260511 for electrical mechanical coordination and responsibilities.

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

### 1.02 QUALITY ASSURANCE

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

B. Code and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 98, Enclosed and Dead-Front Switches.
   3. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
   4. UL 508, Industrial Control Equipment.

C. Comply with NEMA for appropriate size of motor protection. For units not using NEMA rating, use equivalent NEMA size.

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: For each type and size of motor controller and appurtenance.

C. Shop Drawings: Wiring diagrams for each type and size of motor controller.

### 1.04 SPARE MATERIALS

A. Include one spare starter coil for each starter size specified.

### 1.05 MOTOR VOLTAGE INFORMATION

A. Voltages available: 115, 208 and 277 Volt, single phase and 208 and 480 Volt, 3 phase.

B. Circuits designed (in general) for Motors as follows:
   1. Smaller than 3/4 HP: 115, 208 or 277 Volts, single phase.
   2. 3/4 HP and Larger: 208 or 480 Volts, 3 phase.

C. Verify motor sizes and voltages provided under other divisions and notify the A/E if any discrepancies are noted.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Size starters as indicated on the Drawings and specified in this section. Coordinate starter sizes with associated motors and furnish starters matched to motor horsepower.

## 2.02 MANUFACTURERS

A. Manufacturers: Cerus Industrial Building Automation Starter, Square D, Eaton/Cutler Hammer, General Electric, Siemens, Allen-Bradley, or approved.

## 2.03 MOTOR STARTERS

A. Magnetic Motor Starter:
   1. General: NEMA rated. NEMA size rated for motor horsepower or as indicated, NEMA size 1 minimum. Full-voltage, non-reversing (FVNR), unless indicated otherwise. Full-voltage, non-reversing (FVNR), unless indicated otherwise.
   2. Enclosure: Surface-mounted, NEMA 1 enclosure for indoor and NEMA 3R for locations subject to moisture, unless indicated otherwise.
   3. Contactor and Overload Relay: Contactor with minimum 1 NO and 1 NC auxiliary contact and solid state electronic overload relay to protect all phases with field adjustable current setting and trip class for specific motor full load amps. Overload relay with phase failure, phase loss, locked rotor, and stall protection. Include manual reset pushbutton on starter cover to restore normal operation after trip or fault condition.
   4. Integral Control Power Transformer: 50 VA capacity with circuit breaker protected secondary selected for available line voltage and maximum 120 Volt control voltage.
   5. Automation System Control: Include remote run terminals in starter to accept voltage input signal and contact closure. Input voltage shall accept 24 VAC, 120 VAC, 24 VDC, and 48 VDC to allow direct connection of input signal to starter.
   6. Interlocks: Where motor is interlocked with a control damper or control valve, actuator control shall reside within starter enclosure. Starter shall provide voltage output to operate actuator without closing motor circuit. Starter shall close motor circuit and start motor upon receipt of contact closure from limit or end switch confirming control damper or control valve position.

B. Combination Magnetic Starter: Include magnetic motor starter requirements previously specified and a disconnecting method by means of motor circuit protection, UL 489 circuit breaker, or fused disconnect. Include disconnect with lock-out mechanism when starter is in “OFF” position. Disconnecting method as follows:
   1. Current limiting manual motor starter with magnetic trip elements, UL 508 listed. Breaker with UL 508 Type F rating for maximum 100 Amp frame size. Coordinate short circuit rating for use with motor contactor with 30,000 AIC minimum interrupting rating for combination starter.
   2. Fused disconnect with time delay J-style fuses, UL 98 suitable for service entrance protection.
   3. UL 489 breaker with thermal and magnetic mechanisms.

C. Manual Motor Starter:
   1. Horsepower-rated toggle switch type, lockable in “OFF” position to function as motor disconnect. Include thermal overload protection, run status pilot light, and fault pilot light for operation in both manual and automatic control modes. In automatic mode, starter shall integrate with building automation system with terminals within starter for run input, run status output, and fault output. Include interposing run relay and current sensing status output relay within surface mounted enclosure with electronic solid state overload relays, red “RUNNING” pilot light, nameplate, and enclosure.
   2. Enclosures: Surface-mounted, NEMA 1 enclosure for indoor and NEMA 3R for locations subject to moisture, unless indicated otherwise.

D. Pushbuttons, Selector Switches, Pilot Lights, and Similar Devices: Include “HAND”, “OFF”, “AUTO” operation switch and watertight and dust-tight LED pilot lights for “HAND”, “OFF”, “AUTO”, “RUN”, and “OVERLOAD” conditions.

E. Overload Relays: Electronic solid state, sized for nameplate ampacity of motor served.

### 2.04 ADDITIONAL FEATURES

A. Include the following features to meet design performance:
   1. Over and under voltage and phase monitoring, field adjustable for over and under voltage levels. Include time delay before returning to normal operation after trip occurrence.
   2. Measure and display output current on front cover.
   3. Monitor and calculate power consumption (kWh) of motor load and display kW and kWh. Include pulse output (kWh) or 4 to 20 mA analog signal (kW) to automation system to monitor power consumption.
   4. Communication to automation system over BACnet MS/TP to report starter mode, terminal input status, run status, and fault status, voltage, current, power factor, kW, and kWh.

B. Power Factor Correction: Include capacitors for motors 25 horsepower and larger. Size to bring power factor to within range of 0.9 to 0.95. Capacitors fused type with blown fuse indicators mounted on front of starter enclosure. Include discharge resistors when required by NEC.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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.

### 3.04 MOTOR CONTROLLER INSTALLATION

A. Install generally in location shown on the Drawings with exact location chosen to provide necessary code clearances and to preserve maintenance access.

B. In finished areas, install motor protection switches flush and provide suitable stainless steel coverplates.

C. Install on steel frame anchored to the structure adjacent to, but independent of equipment served. Do not fasten to motor, mechanical equipment enclosure, or related supports.

D. For roof-mounted equipment, coordinate supports with architectural and structural to maintain roof integrity. Submit shop drawings.

E. Check for proper motor rotation and reconnect conductors as necessary to provide proper rotation.

F. Comply with requirements in Section 260553 for nameplates.

G. Install fuses in fuseholder so fuse size is visible.

H. Prior to air and water system balancing, verify overload relays match motor nameplate rating. After balancing, adjust overload settings to match actual motor current.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes Surge Protective Devices (SPD) and associated appurtenances used for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients. This specification also describes the mechanical and the electrical requirements for the SPD. The SPD shall be suitable for application in Category A, B and C environments as described in ANSI/IEEE C62.41- 2002.

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

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. ANSI/UL 1449 Third/Fourth Edition, Standard for Safety for Surge Protective Devices.
   2. ANSI C84, American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hertz).
   3. IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1,000 V and Less) AC Power Circuits.
   4. IEEE C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and Less) AC Power Circuits.
   5. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuit.
   6. IEEE 142, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book).
   7. IEEE 1100, IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).
   8. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   9. NFPA 70, National Electrical Code (NEC).
   10. UL 1283, Standard for Safety for Electromagnetic Interference Filters.

C. Units listed and labeled by OSHA Nationally Recognized Test Lab (NRTL). Comply with NEC as applicable to SPDs.

D. SPDs provided by a single manufacturer.

E. Manufacturer Qualifications:
   1. Manufacturer shall have local representation and distribution within 400 miles of the project location to provide installation, technical, warranty, and site observation support services for the project.
   2. Manufacturer/vendor must be capable of supplying SPD for project within 30 days of receipt of order for orders of 25 units and less for models submitted in response to this specification.
   3. Manufacturers shall be certified to latest ISO 9001 standard and shall be registered for the design and manufacturing of SPD devices.
   4. Manufacturer shall provide access to a readily available factory engineer for answering questions about this product.

5. Only firms regularly engaged in the manufacture of SPD products for category C locations (ANSI/IEEE C62.41.1-2002), and whose products have been providing satisfactory service for not less than five years, shall be considered. Upon request, provide a customer reference list, with a minimum of five contact names and current phone numbers. Additional minimum SPD performance requirements apply. Contact project engineer for details.

## 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Certifications:
   1. Specification compliance response sheet referencing each specification section.
   2. Proof of ANSI/UL 1449 Third/Fourth Edition compliance from Nationally Recognized Test Lab (NRTL) accepted by local authority having jurisdiction.
   3. ANSI/UL 1449 Third/fourth Edition Nominal Discharge Current Rating and Voltage Protection Ratings.
   4. UL 1283 filter compliance documentation.
   5. Performance/warranty information.
   6. Manufacturer Qualifications.

C. Product Data:
   1. Submit manufacturer's technical product data, installation instructions, maintenance data, and general recommendations for each type of SPD.
   2. Reference appropriate ANSI/UL 1449 Third/Fourth Edition and IEEE C62.41 performance ratings for intended installation locations.
   3. SPD not listed within specification requires pre-approval of engineer and submission of SPD performance data not listed in this specification. Contact engineer for required performance criteria.

## 1.04 WARRANTY

A. Minimum requirements:
   1. Period: 20 years from the date of substantial completion of service and activation of the system to which the SPD is attached.
   2. Full replacement of a suppressor which is damaged or fails to meet manufacturers published specifications and specifications provided within, without pro-rating value.
   3. No exclusions from failure or damage from any system anomaly (over-voltage, single phasing, lightning strike, etc. (IEEE 62.41.1). Exceptions: failure caused by wiring error, loose or missing Neutral to Ground Bond or Meggar Testing with SPD connected to power system.
   4. Factory or third party testing shall not be required.
   5. Warranty shall apply independent of facility ownership/purchaser.
   6. Replacement unit to be at facility within 7 business days of receipt of written notification of failure at no cost to the customer (exception – custom configuration or special order units).
   7. Replacements: same make, model and configuration as original unit unless otherwise requested or approved.
   8. Manufacturer site visit for validation of warranty claim: manufacturer/vendor must visit site within 3 days of notification at no cost.
   9. No shipping, handling, examination or other fees are allowed.

### 1.05 DELIVERY, STORAGE AND HANDLING

A. Inspect for damage and replace any damaged device.

B. Store in a clean, dry space suitable for equipment and protect against damage.

C. Clean equipment and touch up minor scratches using suitable materials.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Surge Protective Devices:
   1. Innovative Technology.
   2. Current Technologies.
   3. No substitutions.

B. Service Entrance:
   1. Innovative Technology:
      a. 480Y/277V Model PTX160-3Y-201-MT.
      b. 208Y/120V Model PTX160-3Y-101-MT.
   2. Current Technologies:
      a. 480Y/277V Model CG80-277/480-3GY.
      b. 208Y/120V Model CG80-120/208-3GY.

C. Distribution Boards - 800A and higher:
   1. Innovative Technology:
      a. 480Y/277V Model PTX080-3Y-201-MT.
      b. 208Y/120V Model PTX080-3Y-101-MT.
   2. Current Technologies:
      a. 480Y/277V Model CG60-277/480-3GY.
      b. 208Y/120V Model CG60-120/208-3GY.

D. Panelboards below 800A:
   1. Provide with Active Sinewave Tracking.
   2. Innovative Technology:
      a. 480Y/277V Model PTE080-3Y-201-MT.
      b. 208Y/120V Model PTE080-3Y-101-MT.
   3. Current Technologies:
      a. 480Y/277V Model CGF40-277/480-3GY.
      b. 208Y/120V Model CGF40-120/208-3GY.

### 2.01 DESIGN AND PERFORMANCE REQUIREMENTS

A. Design:
   1. SPD shall be compatible with the electrical system voltage, current, system configuration and intended applications and shall be NRTL listed for such application.
   2. Parallel design only with individual protection components:
      a. Line to Ground and Line to Line for Delta and High Resistance Grounded systems.
      b. Line to Ground, Line to Neutral and Neutral to Ground for Wye and Single Phase distribution systems.

3. Metal-Oxide Varistors (MOV) components shall be utilized. Selenium cell, air gaps, gas tubes or other components are not allowed.
4. Maximum continuous operating voltage (MCOV) of all components (based on ANSI C84.1 standard voltages), shall be not less than 125% for 120/208 and 120/240V systems and not less than 115% for all other systems.
5. Short Circuit Current Ratings (SCCR) shall be ≥ 100kAIC and not less than 115% of available fault current for location SPD is to be installed.
6. Visual indication of protection status on each phase, visible from the front of the equipment.
7. Protection Status:
   a. Normally open and normally closed contacts for remote monitoring.
   b. Rated a minimum of .5 Amps, AC or DC.
   c. Shall change state upon device failure or loss of power.
8. As a minimum, Branch Panel, Sub-Panel and series installed (branch circuit) SPD shall include a passive circuit which allows the SPD to actively follow the voltage waveform and provide a clamping envelope to limit low level IEEE C62.41 ringwaves (of either polarity) at all locations on the sine wave.
9. Complete, comprehensive installation instructions shall be provided for the SPD.
10. Enclosure:
    a. NEMA rated metal enclosure appropriate for environmental conditions and exposure at point of installation.
    b. Designed to allow connection of the SPD without sharp bends in the conductors.
    c. Provide metallic flush cover where installed in finished areas.

B. Performance and Ratings:
   1. Minimum durability and performance requirements are described below in accordance with test procedures outlined in ANSI/IEEE C62.45 & ANSI/UL 1449 Third/Fourth Edition. Test documentation shall be provided as part of the submittal package. Information shall be provided in a format which is easily to analyze and review. The following test data shall be submitted as manufacturer published literature:
      a. Provide Peak Surge Current (Single Pulse Rated, 8/20μS, by mode, Amperes with ≤ 10% degradation) with submittals document for each SPD proposed. For all electrical equipment located at Service Entrance or Category C locations, Surge current rating (per mode) shall be a minimum of 80kA for IEEE C62.41.1-2002 – Category C Medium and Low Exposure Locations (low lightning exposure as determined by Isokeraunic Map) and a minimum of 300 kA for IEEE C62.41.1-2002- Category C High Exposure locations (high lightning exposure as determined by Isokeraunic Map) or for mission critical facilities such as hospitals or data centers. For SPDs with component level fusing, manufacturer shall provide recommended peak surge current ratings as necessary to meet durability requirements provided for in this specification.
      b. Provide independent NRTL laboratory proof of completion of such tests and test data with submittal data. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G & N-G) with submittals.
      c. Surge current rating (per mode) shall be a minimum of 40 kA for branch panel models for IEEE C62.41.1-2002 – Category B & C Switchboard Locations where upstream protection is provided by Service Entrance SPD. For SPDs with component level fusing manufacturer shall provide recommended peak surge current ratings as necessary to meet durability requirements provided in this specification.
      d. Provide EMI/RFI Attenuation with submittals as per Mil Std-220 tests. Attenuation: 40 dB at 100 kHz.
      e. SPD durability and let-through performance shall meet Hargis Engineering criteria. Contact project engineer for detailed information on performance requirements.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 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 work of this section.

### 3.03 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. Drawings.

### 3.04 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

### 3.05 SPD INSTALLATION

A. General Application & Installation Requirements:
   1. Per the manufacturer's installation instructions.
   2. Per electrical installation detail (when provided).
   3. Per Installation Checklist.
   4. NFPA 70 (NEC) Requirements.
   5. Per IEEE C62.41.2, 141, 142 and 1100.
   6. Local authority having jurisdiction.
   7. Requirements provided by Project Engineer.

B. Use approved Flush Mount Kits for External Device Flush Mount Installations. Metallic flush kits for flush mount installations (external devices) on new and retrofit applications for panels. Kits shall include supports for fastening to structural members and shall include a face plate matching SPD finish. Retrofit kits shall be capable of being installed next to the panel after drywall has been installed without the need for patching or refinishing of the wall. At contractor’s option, provide custom manufactured flush mounting kit including supports for fastening to structural members and face plate matching SPD finish to manufacturer and obtain written approval prior to submittals.

C. Units shall not tap directly to the bus without upstream over-current protection unless tap conductors are protected at their termination by NRTL listed Disconnect, Over-current and Short Circuit Protective Devices (Circuit Breaker) properly rated for conductor and SPD Device Protection as per SPD NRTL listing and NEC requirements. Properly rated short circuit and overcurrent protection device shall always be installed at the source (i.e. in switchboard, panelboard, or other electrical apparatus) unless approved by Project Engineer.

D. Manufacturer/vendor shall provide technically qualified personnel as necessary to visit project site for pre-installation training of contractor.

E. Contractor shall contact manufacturer/vendor to arrange for on-site training, and shall submit written documentation of training (including meeting minutes listing; attendees, training dates, subject covered, etc.) to Project Engineer within 15 business days of training date. Training shall include:
   1. Mounting of SPDs and Flush Mount Kits (where applicable).
   2. Proper installation of SPD leads for minimal let through voltage.
   3. General SPD ratings (i.e. voltage, peak surge current, etc.) and appropriate installation and application.
   4. Overcurrent and short circuit protection requirements.

F. Specific project installation requirements as per drawings, specifications and Project Engineer's communication.

G. Clean SPD units and flush mount covers and touch up with matching paint as necessary. SPDs and Flush Mount Plates with physical damage will not be accepted.

H. Manufacturer or vendor shall provide technically qualified personnel as necessary to conduct review of SPD installation as needed to confirm proper installation of all SPDs.

I. Manufacturer/vendor personnel performing site visit shall, as a minimum:
   1. Be qualified to evaluate installation.
   2. Be "Qualified" as per OSHA requirements.
   3. Have appropriate Electrical Personal Protective Equipment as per state and federal OSHA requirements and NFPA 70E.
   4. Have appropriate electrical safety training on arc flash, arc blast and electrical shock hazards.
   5. Have, and follow a written electrical safety program based on state and federal OSHA requirements and NFPA 70E.

J. It is responsibility of manufacturer/vendor to provide appropriate training, procedures, equipment, etc. as necessary to help ensure workers safety. Project Engineer is not responsible for minimum safety requirements, safety review or safety planning for manufacturer/vendor personnel.

K. Contractor shall contact manufacturer/vendor to arrange for inspection of SPD installation, and shall submit written documentation of manufacturer/vendor inspection (including meeting minutes listing; attendees, training dates, inspection report, noted deficiencies, additional subjects covered, etc.) to Project Engineer within 15 business days of inspection date. Inspection shall review and document installation by physical location, including:
   1. Mounting of SPDs and Flush Mount Kits (where applicable).
   2. Proper installation of SPD leads for minimal let through voltage.
   3. SPD ratings (i.e. voltage, peak surge current, etc.) and appropriate installation and application.
   4. Overcurrent & short circuit protection requirements.
   5. Compliance with project installation requirements as noted in specifications, one-line drawing details and specific written communication of special installation requirement provided by Project Engineer.

L. Project Engineer or their appointed representative, may also perform inspection of the installed SPDs. Engineer reserves the right to document installation deficiencies and require additional corrections to the installation as necessary to comply with manufacturer installation requirements, project requirements and specifications.

M. Use a low impedance cable assembly at locations where more than 30” of conductor is required to connect the SPD to a circuit breaker.
   1. Acceptable manufacturer: Current Technology HPI Series or equivalent.

N. A final installation report shall be submitted to Project Engineer as part of project operations and maintenance documentation. Final installation report shall include inspection documentation and documentation confirming correction of all noted installation deficiencies.

## 3.06 SERVICE ENTRANCE

A. Service Entrance Installation Requirements:
   1. One primary suppressor at each utility service entrance to the facility or as indicated on the drawings.
   2. Suppressors shall be connected to properly rated disconnect with overcurrent and short circuit protective device connected on the load side of the service entrance disconnecting means in accordance with NEC requirements and manufacturer installation instructions.
   3. Conductors between suppressor and point of attachment shall be kept as short and straight as possible and shall be twisted together.
   4. Suppressor's ground shall be bonded to enclosure frame and the service entrance ground bus, and conduit between the SPD and the switchboard must provide secure electrical/mechanical connections.
   5. SPD shall be NRTL labeled with at 200 kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.
   6. SPD shall be NRTL labeled as Type 1 or Type 2 as necessary for installation (verifiable at NRTL website).
   7. All field applied devices require the NRTL Listing with appropriate label reflecting such listing.

## 3.07 SECONDARY SUPPRESSORS FOR DISTRIBUTION & BRANCH PANELS

A. Distribution Centers, and Branch Panel applications:
   1. Install one secondary suppressor at each Distribution Panel, and Branch Panel/Sub-Panel location or as indicated on the drawings.
   2. Suppressor shall be connected to properly rated disconnect with overcurrent and short circuit protective device in accordance with NEC requirements and manufacturers installation instructions.
   3. The SPD shall not limit the use of feed through lugs, sub-feed lugs and sub-feed breaker options. Where feed through lugs, bus tap or circuit breaker is used to feed adjacent sub-panel, SPD shall be installed at first panel served by feeder and conductor terminations between primary panel and adjacent panel shall be installed in such a manner to keep wiring as short as possible (i.e. use bottom lug on output of panel and bottom lugs on input of second panel).
   4. Conductors between suppressor and point of attachment shall be kept as short and straight as possible and shall be grouped and twisted together. Mount the SPD directly adjacent to the circuit breaker closest to the neutral bus, so the maximum length of connecting wiring shall not exceed 18 inches for all leads without written permission of the Engineer.

5. Suppressor's ground shall be bonded to enclosure frame and the equipment ground bus, and the electrical fitting between the SPD and the switchboard must provide secure electrical/mechanical connections.
6. The electrical gear shall be capable of being re-energized upon removal of the SPD.
7. SPD shall be NRTL labeled as Type 1 or Type 2 (verifiable at NRTL website) as necessary for installation.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes interior and exterior luminaires, lamps, ballasts/drivers and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, and Sections 260500, and 260510 apply to Work in this section.

C. Comply with requirements in other specification sections for concrete used for embedding poles, pole foundations, and footings for exterior area luminaire poles, standards, and foundations. Pole bases included in this section.

D. Where conflict occurs, the Luminaire (Light Fixture) Schedule shall take precedence.

### 1.02 QUALITY ASSURANCE

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

B. Codes and Standards: NFPA 70, National Electrical Code (NEC), including local amendments, as applicable.

C. Comply with NEC and NEMA for installation and construction of luminaires. Components, Devices and Accessories shall be listed and labeled for intended use as defined in NEC, by a qualified testing agency and acceptable to the AHJ. Luminaires shall be UL listed and be labeled.

D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

E. Each lamp type shall be of the same manufacturer.

F. Each ballast type shall be of the same manufacturer.

G. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

H. Luminaires in damp or wet locations shall be listed for such use and labeled as either "Suitable for Damp Locations" or "Suitable for Wet Locations".

### 1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of luminaire and appurtenance.
   1. Submit product data for associated lamp, ballast (or driver) for each luminaire type.
   2. Create a matrix encompassing all luminaire types with ballast and lamp type, including manufacturer name and part number(s).
   3. Submit copy of individual and/or tandem warranties for luminaire, lamp and ballast (or driver), as applicable.
   4. For solid state lamps:
      a. Provide IES LM-79 report.

b. Provide IES TM-21 report.
c. Provide Bin Coding System Chart, with appropriate target CCT reference line, identifying which bin corresponds to the lamps supplied to each luminaire. For luminaires with multiple solid state lamps, identify which bins shall be included for color mixing.

C. Qualifications: Indicate manufacturer qualifications as identified in Part 2.

D. Shop Drawings:
1. Submit dimensioned drawings of each type of luminaire. Submit in booklet form with separate sheet for each luminaire, assembled by luminaire "type" in alphabetical order with proposed luminaire and appurtenances clearly indicated on each sheet.
2. Submit support and hanging details for luminaires weighing more than 56 pounds and pendant hung luminaires requiring support design approved by the AHJ.
3. Submit copy of manufacturer installation instructions for each luminaire type.

E. Test Reports:
1. Comply with commissioning requirements in Section 260810.
2. Perform field test reports.
3. Submit completed copy of reports at the time of substantial completion. Include copy in the Operation and Maintenance Manual.

## 1.04 EXTRA MATERIALS

A. Turn over to the Owner and obtain signed receipt.

B. Include copy of transmittal(s) and receipt(s) in Operation and Maintenance Manual.

C. Lamps:
1. Furnish five percent (but not less than one solid state lamp) of solid state lamps for each type used on the project that has replaceable components.

D. Drivers:
1. Furnish two percent (but not less than one driver) of solid state drivers/power supplies for each type used on the project.

E. Exit Signs: Furnish and install ten percent (but not less than one exit sign) of each type used on the project. For each exit sign, include rough-in and fifty feet of branch circuit raceway and wiring connected to a local (non-emergency or emergency) circuit, as appropriate or indicated by AHJ. Location of spare exit signs as required/directed by AHJ.

## 1.05 DEFINITIONS

A. CU: Coefficient of utilization.

B. HID: High-intensity discharge.

C. HO: High output.

D. IC: Insulation contact.

E. Lamp: The complete light source package, including all associated components (base, pins, filament, outer bulb, solid state components, etc.) that make up a single unit.

F. Light: Radiant energy sensed or seen.

G. Light Fixture: Luminaire.

H. Lumens: Measured light output of lamp (or luminaire if using solid state lamping).

I. Luminaire: A complete lighting unit consisting of a lamp, ballast (or driver) as required together with the parts designed to distribute the light and to position and protect the lamp, as well as the electrical parts required to generate the light. This may include the means to connect to a power supply.

J. Rated Lamp Life:
   1. Incandescent, Fluorescent and HID lamps: The time after which half of the tested sample of lamps have extinguished.
   2. Solid State lamps: L-70, the time after which 70% of the initial lumen output is maintained out of the respective luminaire.

**1.06 COORDINATION**

A. Review luminaire types with respective ceiling type prior to ordering. Initiate a meeting with the ceiling installer and issue meeting minutes to the A/E. Inform A/E where mounting method conflict occurs.

B. Review luminaire types with location of building insulation prior to ordering. Initiate a meeting with the insulation installer and issue meeting minutes to the A/E. Inform A/E where non-IC rated luminaires are in conflict with the building insulation.

C. Review luminaire types with final millwork shop drawings. Initiate a meeting with the casework installer and issue meeting minutes to the A/E. Verify luminaires will fit where specified in or adjacent millwork prior to rough-in.

D. Coordinate layout and installation of luminaires and associated support methods with all trades.

E. Facilitate coordination meetings once a month (throughout construction) with the general contractor, ceiling installer, sprinkler installer, HVAC installer, plumber, telecommunications installer and all other applicable trades. Shop drawings shall be adjusted accordingly and resubmitted for A/E review and approval. Log shall be kept on site with meeting dates and meeting minutes.

F. Develop 3D shop drawings for coordination with other trades. Combine model with other trades for use during coordination meetings.
   1. Meet the requirements indicated in Division 01.
   2. Utilize Revit, AutoCAD 3D or Navisworks.

**1.07 WARRANTY**

A. Comply with requirements in Division 01 and Section 260500 – Warranty.

B. Warranty period as indicated in Section 260500 shall establish minimum requirement, unless otherwise noted.

C. Occupancy-Vacancy Sensors: 5 years.

D. Solid State Lamps and Drivers: 5 years.

E. Batteries (in luminaires or unit equipment): Manufacturer's standard form in which manufacturer shall repair or replace components of rechargeable batteries that do not comply with minimum Code required life, within 5 years.

## PART 2 PRODUCTS

### 2.01 LUMINAIRES

A. Housing: Metal parts shall be free from burrs, sharp corners and edges. Sheet metal components shall be formed and shall not warp or sag. Luminaires shall be free of light leaks while also providing the required ventilation so as not to degrade the rated photometric performance and rated life of lamps and/or ballasts. Adjustable luminaires shall utilize positive locking devices to set aiming angle; luminaire shall be able to be relamped without affecting aiming angle.

B. Lenses: Where utilized, acrylic plastic shall be 100% virgin acrylic, highly resistant to yellowing and other changes due to aging, exposure to heat and ultraviolet radiation. Minimum thickness of 0.125 inches.

C. Hardware: Finish ferrous mounting hardware and accessories to prevent corrosion and/or discoloration to any and all adjacent materials. Hardware for steel or aluminum luminaires shall be cadmium, or approved, plated. Hardware for stainless steel luminaires shall be stainless steel. Hardware for bronze luminaires shall be stainless steel or bronze.

D. Sockets: Linear fluorescent lamp sockets shall be 4-position positive stop lamp-lock style with knife-edge contacts. HID sockets shall be porcelain for mogul or medium base lamps, pulse rated as required; sockets shall be keyed for all position oriented lamps.

E. Reflecting Surfaces: The following minimum reflectance values shall be met:
   1. White Surfaces: 85%.
   2. Specular Surfaces: 90%.
   3. Anodized Aluminum Surfaces: 93%.

F. Latches: Latches for luminaire doors/louvers, where applicable, shall be spring type and shall operate freely and easily without excessive force.

G. Wiring
   1. Cords/cables between luminaire components shall have a minimum temperature rating of 105°C.
   2. Cords/cables shall be fitted with appropriate strain relief connectors and/or weathertight entries, where required by application.
   3. No internal wiring shall be visible from normal viewing angles.
   4. Cords/cables to pendant luminaires shall match color of respective canopy.
   5. Internal and/or factory wiring shall be a minimum size of 18 AWG.

H. Installed Where Subject to Damage: Where luminaires are installed subject to physical damage and contain metal halide lamping, the luminaires shall consist of means of protection where the lamp is completely enclosed by glass or plastic/acrylic. If the lamp breaks, the glass shards shall not escape the luminaire and the lamp shall not emit ultraviolet light outside the luminaire.

I. Solid State LED luminaires shall be on at least one of the following (or be pre-approved by the A/E):
   1. U.S. Department of Energy Energy Star Qualified Luminaires Product List.
   2. Designlights Consortium Qualified Products List (where applicable category exists) or Lighting Design Lab LED Qualified Luminaire and Tubular LED Lamp List.

## 2.02 LAMPS

A. Refer to Luminaire (Light Fixture) Schedule for additional information.

B. Notify and send A/E manufacturer's recommendations for lamp/ballast combination if different from products specified.

C. Solid State:
   1. LED:
      a. Manufacturers:
         1) Minimum of 5 year history of producing and/or installing LEDs in North America.
         2) Philips/Lumileds, Osram/Sylvania, General Electric, Cree, Nichia, Samsung, or approved.
      b. Must be on U.S. Department of Energy Energy Star Qualified Lamps Product List.
      c. Must be on the Lighting Design Lab's LED Qualified Lamp List.
      d. Replaceable modules shall be designed to Zhaga Consortium standards.
      e. Lamps shall not use any energy when 'off'.
      f. CCT throughout life of lamp shall be within +/- 200 K of respective specified value.
   2. Organic LED lamps are not allowed.

## 2.03 DRIVERS

A. Refer to Luminaire (Light Fixture) Schedule for additional information.

B. Notify and send A/E manufacturer's recommendations for lamp/ballast combination if different from products specified.

C. Quantities: For continuous linear light fixtures provide quantity of ballasts/drivers required to support the circuiting and control shown on the contract documents.
   1. Daylight zones: Provide drivers for control within daylight zones for linear fixtures that are mounted in any portion of a daylight zone. If 50% or more of a control length is in a daylight zone it shall be controlled within that zone.
   2. For linear lengths that cross primary/secondary zones control with the more stringent daylight zone.
   3. Control Length: Maximum eight foot, minimum four foot.

D. Solid State Drivers/Power Supplies:
   1. Manufacturers:
      a. Minimum of 5-year history of producing and/or installing drivers in North America.
      b. Philips/Advance, Osram Sylvania, General Electric, Universal, Thomas Research, or approved.
   2. When not in the luminaire, the housing shall be plenum rated.
   3. Poke-in wire trap connectors or integral leads color coded per ANSI C82.11.
   4. Withstand +/- 10% voltage fluctuation with no compromise of performance or life cycle.
   5. +/- 5% output across published load range.
   6. 120-277 Volt rating.
   7. PF greater than 0.9, at specified voltage.
   8. Minimum efficiency of 70% at rated full load.
   9. Maximum case temperature rating of 70°C.
   10. THD less than 20%.
   11. Class A sound rating.

12. Minimum operating temperature of -20°F.
13. Shall tolerate sustained open circuit and short circuit output conditions without damage and without need for external overcurrent protection.
14. No PCB allowed.
15. Comply with ANSI/IEEE C62.41.1 & C62.41.2, Category A for transient protection.
16. Dimmable, as specified in the Luminaire (Light Fixture) Schedule.

**2.04 EGRESS**

A. UL 924 Listed.

B. Battery Packs (Emergency Ballasts) in General Luminaires:
   1. Manufacturers: Philips/Bodine, Iota Engineering, or approved.
      a. Solid State driver assemblies with integrated components are allowed.
   2. Must fit inside luminaire's ballast compartment. In case of remote ballast installation, battery pack shall be installed adjacent ballast and marked accordingly on the record drawings (as-builts).
   3. Must initiate within 3-10 seconds of power failure and allow for 90 minutes of operation.
   4. Compatible with 1-lamp, 2-lamp, 3-lamp, 4-lamp and dimming ballasts.
   5. Minimum 1,100 lumens of output for linear fluorescent lamps and 750 lumens for compact fluorescent lamps.
   6. Allow for multi-lamp operation.
   7. 120/277 Volt rating.
   8. End-of-lamp-life compatible.
   9. Damp listed.
   10. High temperature, maintenance-free nickel-cadmium sealed battery, minimum 7 years of operation.
   11. Self-testing, every 30 days, without horn. Indicator light shall flash if problem is detected.
   12. Must automatically switch back to normal power once available.
   13. Test switch, located inside the luminaire if possible; if not possible, notify A/E and locate switch and indicator light per A/E direction prior to rough-in.

C. Unit Equipment:
   1. Manufacturers: Hubbell Lighting/Dual-Lite, Cooper Lighting/Sure-Lites, Acuity Brands/Lithonia, Philips/Chloride, Philips/Lightolier, or approved.
   2. Must initiate within 3-10 seconds of power failure and allow for 90 minutes of operation.
   3. Maintenance-free lead-calcium sealed battery, minimum 7 years of operation.
   4. Must contain visual indicator status of normal power.
   5. Automatic self-diagnostic monitoring and testing of unit operation. Self-test every 28 days.
      a. Must contain visual indicator status of service alerts for 'battery fault', 'charger fault', 'transfer fault' and 'lamp fault'.
      b. Manual test switch.
   6. Must automatically switch 'off' once normal power is available.
   7. Automatic low voltage disconnect battery protection.
   8. Automatic normal power lockout circuit.

## PART 3 EXECUTION

### 3.01 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. Work that requires modification due to unsatisfactory conditions, deemed by the A/E, shall be corrected and completed to the satisfaction of the A/E at no additional cost to the contract.

### 3.02 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 work of this section.

### 3.03 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. Temporary Lighting for Construction Use: Contractor shall provide lighting used during the construction period for construction tasks. Permanent luminaires that are part of the project may not be utilized for this use.

C. Temporary Lighting required as part of Project Phasing: As approved by A/E, permanent luminaires may be used for temporary lighting means. Install and energize the minimum number of luminaires necessary for the task. When construction is sufficiently complete, remove the temporarily installed luminaires in a neat and workmanlike manner, dissemble, clean thoroughly, replace lamp(s) and ballast(s) and install in permanent location per the contract documents. Permanently installed luminaires deemed by the A/E to be damaged shall be replaced at no additional cost.

D. Remote Mounting of Ballasts (where indicated on the drawings and/or approved by the A/E): Distance between the remote ballast and respective luminaire shall not exceed distance recommended by the ballast manufacturer. If recommended distance conflicts with the drawings, notify the A/E prior to rough-in.

### 3.04 INTERIOR LUMINAIRE INSTALLATION

A. Install luminaires at locations and heights as indicated on the Drawings, in accordance with luminaire manufacturer’s written instructions, applicable requirements of NEC, NESC, NECA’s “Standards of Installation”, NEMA standards, and recognized industry practices to ensure that luminaires fulfill requirements. Luminaires shall be installed exactly level, secure and plumb with respective building lines. Wall mount and ceiling mount luminaires shall be securely and tightly attached to their respective mounting surface. Lay-in luminaires shall sit flush with grid ceiling system, doors shall swing completely open in the designed direction.

B. Luminaire Supports:

1. General: Comply with IBC and NEC (including all local amendments) as interpreted by AHJ for luminaires mounted in suspended ceilings. Lay-in and pendant luminaires shall not be supported by lay-in suspended grid ceiling system and must be attached to structure.

2. Support Requirements:
    a. Include flexible ball joint hangers for pendant and stem hung luminaires at designated points of support.
    b. Equip hooks used to hang luminaires with safety latches. Include supports, brackets, clips, screws and miscellaneous items for mounting luminaires.
    c. Include locking catches, screws, safety chain(s) or safety cable(s) for detachable luminaire parts, luminous ceiling accessories, louvers, diffusers, lenses and reflectors.
3. Seismic Restraints:
    a. For Luminaires Weighing Less than 10 Pounds: Install (1) slack No. 12 gauge hanger wire from luminaire to structure above.
    b. For Luminaires Weighing 10 to 56 Pounds: Install (2) independent slack No. 12 gauge hanger wires from opposite corners of luminaire to structure above.
    c. For Luminaires Weighing More than 56 Pounds: Support directly from the structure above by hangers approved by the AHJ. Comply with requirements in Section 260548 for seismic restraints.
    d. For Pendant Hung Luminaires: Support directly from structure with No. 9 gauge hanger wire or alternate support without using ceiling suspension system for direct support approved by the AHJ. Comply with requirements in Section 260548 for seismic restraints.

C. Fire Rated Assemblies: Provide gypsum board protection acceptable to the AHJ to ensure fire rating of ceiling or wall in which luminaires are installed. Maintain manufacturer's recommended ventilation requirements.

D. Provide backing in wall cavity to reinforce support for wall mounted luminaires.

E. Luminaire Contact with Building Insulation: When building insulation is installed at a location where contact with luminaires is unavoidable, IC-Rated luminaires shall be utilized. Where insulation is present and an approved IC-Rated luminaire is not available, provide a gypsum board assembly around the luminaire, maintaining all recommended ventilation requirements, to separate luminaire from adjacent insulation.

F. Protect installed luminaires from damage during construction period through date of substantial completion. Damaged luminaires, including associated components, shall be replaced in their entirety.

G. Installed in a Shower or Wet Location: If luminaires have exposed metal parts that are grounded, respective circuit breakers shall be GFCI. If luminaires have exposed metal parts that are not grounded, they shall not be utilized and an approved luminaire without exposed metal parts shall be provided. Inform A/E prior to ordering luminaires.

H. Exit Signs: Verify color of lettering with AHJ prior to ordering.

## 3.05 EXTERIOR LUMINAIRE INSTALLATION

A. Coordinate with work of other trades as necessary to properly interface installation of exterior lighting.

B. Install lighting poles and standards plumb on concrete pole bases as indicated on the Drawings with anchor bolts and reinforcing bars. Coordinate anchor bolt size, pattern and orientation prior to base installation. Coordinate size and location of bases prior to installation. Hand rub exposed concrete to uniform, smooth finish. Support during backfilling and anchoring to foundations. Comply with requirements in Section 260510 for excavation and backfilling. Refer to Contract Drawings for additional information.

C. Fuses for Exterior Pole-Mount Luminaires: Include fuses in each phase conductor, sized for 1-1/2 times maximum full load ballast current served by each conductor, Bussmann KTK or approved. Do not exceed circuit overcurrent protective device rating. Include fuse holder at handhole or in base junction box with “breakaway” receptacles for conductors running to top of poles, Bussman HEB or approved. Include fuse blanks in neutral conductors.

D. Install with sufficient space for hand access and cable entrance holes for installation of underground cabling. Make splices in pole or pole base using Scotchcast 400 resin for watertight connections.

E. Wall Mount: Exterior building mount luminaires shall coordinate/align with building elements. Luminaires and respective mounting and rough-in means shall align in the center of building elements and shall not split unevenly across multiple elements. Notify A/E of conflicts prior to rough-in.

## 3.06 FIELD QUALITY CONTROL

A. Upon completion of installation of luminaires and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Repair malfunctioning units on site, then retest to demonstrate compliance. If not possible to repair on site, remove and provide new units and retest. Include copy of test reports in the Operation and Maintenance Manual.

B. Clean luminaires in their entirety of dirt and debris upon completion of installation, including but not limited to housing, lens(es), lamp(s) and louver(s) within (7) days of substantial completion.

C. At Substantial Completion, remove and provide new lamps in interior and exterior luminaires which are observed to be noticeably dimmed due to Contractor’s use and testing, as judged by the A/E.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The following sections apply to Work in this Division:

1. Section 260500 General Electrical Provisions
2. Section 260510 Basic Electrical Materials and Methods
3. Section 260511 Electrical Connections for Equipment
4. Section 260512 Electrical Demolition
5. Section 260519 Wire and Cables
6. Section 260529 Supporting Devices
7. Section 260533 Raceway Systems
8. Section 260553 Electrical Identification
9. Section 260534 Outlet Boxes

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Work includes the following:
   1. Structured Cabling System supporting various low-voltage systems
   2. Telecommunications Rooms and Spaces
   3. Grounding and Bonding Infrastructure
   4. Manufacturer Certification

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and 260500 sections apply to Work in this section.

### 1.02 RELATED SECTIONS

A. Related Sections
   1. 260500 – General Electrical Provisions
   2. 260510 – Basic Electrical Materials and Methods
   3. 260533 – Raceway Systems
   4. 260534 – Outlet Boxes
   5. 282300 – IP Security Video System

### 1.03 QUALITY ASSURANCE

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

B. Codes and Standards:
   1. Installation Standards: Comply with following standards for cable and equipment installations. Publications shall be latest issue and addenda:
      a. NEC, National Electric Code.
      b. NESC, National Electric Safety Code.
      c. TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises.
      d. TIA-568-C.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
      e. TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
      f. TIA-568.3-D, Optical Fiber Cabling Components Standards.
      g. TIA-569-D, Commercial Building Standard for Telecommunications Pathways and Spaces.
      h. TIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Building.
      i. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises.
      j. TIA-758-B, Customer Owned Outside Plant Telecommunications Cabling Standard.
      k. TIA-862-B, Structured Cabling Infrastructure for Intelligent Building Systems.
      l. IEEE 802.3-2000. Ethernet Standard.
      m. BICSI Information Transport Systems Installation Methods Manual.
      n. BICSI Telecommunications Distribution Methods Manual.

2. Contractor shall have read the above documents and shall be familiar with the requirements that pertain to this installation. The documents may be obtained from:
   a. Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, http://global.ihs.com/
   b. BICSI, 8610 Hidden River Parkway, Tampa, FL, 33637, 800-242-7405, www.bicsi.org
3. Materials:
   a. UL listed and labeled. Install label to be visible.
   b. Equipment: Regularly catalogued items of manufacturer and supplied as complete unit in accordance with manufacturer's standard specifications with optional items required for proper installation unless otherwise noted in this section.
   c. Telecommunications connectivity and cabling independently tested to meet current TIA standards.

C. Qualifications:
1. Contractor performing work specified in this section is required to have special skills obtained by education, experience, or both.
2. Contractors bidding work specified herein shall have a minimum of seven years of experience in the construction, testing, and servicing of systems of the type and magnitude specified in this section.
3. Contractor shall be a certified installer of the telecommunications system and pre-qualified by the manufacturer for the purpose of offering the Applications Assurance warranty at the time of bid.
4. Contractor shall have direct access to the tools and test equipment required to complete the Work at the time of bid.
5. Project manager (in office) and superintendent (field) shall have 5 years of experience at project manager and superintendent levels, respectively, on completed telecommunications projects of like magnitude and complexity as to this project. Project manager shall be certified as a Registered Communications Distribution Designer (RCDD) through Building Industry Consulting Service International (BICSI).
   a. RCDD shall be a direct employee of the company bidding on said Work.
6. Field technicians who will work independently at any given time during the project on the structured cabling system shall have a minimum of 3 years' experience on completed telecommunications projects of like magnitude and complexity as to this project. Field technicians working at job site shall have completed a copper technician installation training class conducted by the warranting manufacturer or BICSI.
7. Field technicians who will work independently at any given time during the project on the optical fiber systems shall have a minimum of 3 years' experience on completed telecommunications projects of like magnitude and complexity as to this project. Field technicians working at the job site shall have completed an optical fiber technician installation training class conducted by the warranting manufacturer or BICSI.

## 1.04 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.
1. Submit complete at one time. Partial product submittals are not acceptable and will be returned unreviewed.

B. Pre-Construction Submittal:
1. Product Data
   a. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.

b. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
c. Submit Product Data information sheets for coordination with item and model number.
d. Where more than one product is indicated on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
e. Submit network test equipment proof of calibration by manufacturer.
f. Submit resumes and certifications of technicians and project manager who will support this project. Certifications shall include:
    1) Manufacturer's certification to provide warranty
    2) RCDD certification
    3) Copper and optical fiber installation certification
    4) Approved manufacturer classes satisfactorily completed

2. Shop Drawings
    a. Submit Shop Drawings of telecommunications cabling systems.
    b. Coordinate with other trades prior to submittal and start of installation.
    c. Show exact routing of horizontal cabling for workstation distribution throughout building, and intrabuilding and interbuilding copper and optical fiber backbone cabling.
    d. Label workstation devices to identify cabling being terminated in telecommunications rooms and spaces.
    e. Prepare shop drawings using AutoCAD/ Revit software or as approved by the Owner. Submit shop drawings full size in PDF format.
        1) Project was created in Revit, AutoCAD files shall be extracted from the Revit model by the Contractor.

C. Test Reports:
1. Prepare test reports and submit to the Owner's Representative an electronic copy of the detailed test results, including overall test summary report.
2. Include a copy of the detailed test reports on flash drive in each Operation and Maintenance Manual.
3. Include a hard copy of the summary test sheets in each Operation and Maintenance Manual.
4. Submit electronic copies in PDF and LinkWare software formats, including LinkWare reader software.

D. Record Drawings:
1. Keep complete set of telecommunications drawings in job-site office updated within 3 days to show actual installation of cabling and equipment during construction.
2. Use of this set of drawings for recording as-built conditions.
3. Indicate where material, equipment, and system component are installed differently from that indicated on the Contract Drawings, clearly and neatly using ink or indelible pencil in color red during construction.
4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner's Representative for review and acceptance.
5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request (from architect) final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.
6. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.

7. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format, on flash drive.

E. Project Closeout:
1. Submit closeout documentation to the Owner's Representative and Architect under provisions of Division 01, Section 260500 and this section.
2. Provide project closeout documentation including but not limited to; test result documentation, Record Drawings, manufacturer warranty certificates and Operation and Maintenance manuals.

## 1.05 DEFINITIONS

**Accessible ceiling:** An area above acoustical ceiling tiles/grid (or lay-in type ceilings) with a readily accessible space. Gypboard ceilings with access hatches and open to structure spaces shall not be considered accessible ceilings

**Administration:** Methodology defining the documentation requirements of a cabling system and its containment, the labeling of functional elements, and the process by which moves, additions, and changes are recorded

**Bonding:** Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed

**Cable:** An assembly of one or more insulated conductors or optical fibers within an enveloping sheath

**Cable run:** Length of installed media, which may include other components along its path

**Cabling:** System of cables, cords, and connecting hardware

**Channel:** End-to-end transmission path between 2 points at which application-specific equipment is connected including test cords and patch cords for a maximum total distance of 328 feet (100 meters)

**Connecting hardware:** Device, or combination of devices, used to connect cables or cable elements

**Consolidation point:** Location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways

**Cross-connection:** Connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end

**Demarcation point:** Point where operational control or ownership changes

**Equipment room:** Environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect

**Ground:** Conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of earth

**Horizontal cabling:** Distribution media that connects the telecommunications outlet/connector at the work area and the first piece of connecting hardware in the horizontal cross-connect

**Horizontal cross-connect:** Group of connectors that allows equipment and backbone cabling to be cross-connected with patch cords or jumpers

**Infrastructure (telecommunications):** Collection of those telecommunications components, excluding equipment, that together provides basic support for the distribution of information within a building or campus

**Local area network (LAN):** Standard industry term for a network installation that serves a relatively small area (for example, structured cabling installation serving a building)

**Main cross-connect:** Cross-connect normally located in the (main) equipment room for cross-connection and interconnection of entrance cables, first-level backbone cables, and equipment cables

**Metropolitan area network (MAN):** Data communications network that covers an area larger than a campus area and smaller than a wide area network

**Modular jack:** Female telecommunications connector that may be keyed or unkeyed and may have 6 or 8 contact positions

**Outlet/connector (telecommunications):** Connecting device in the work area on which a horizontal cable or outlet cable terminates

**Patch cord**: Length of cable with connectors on both ends used to join telecommunications circuits/links at the cross-connect

**Patch panel:** Connecting hardware system that facilitates cable terminations and cabling administration using patch cords

**Pathway:** Sequence of connections that provides connectivity between devices on a network or between networks on an internetwork; the vertical and horizontal route of the telecommunications cable; a facility for the placement of telecommunications cabling

**Permanent link:** Test configuration for link excluding test cords and patch cords for maximum total distance of 295 feet (90 meters)

**Plenum:** Compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system

**Telecommunications Room:** Enclosed architectural space for housing telecommunications equipment, cable terminations, and cross-connect cabling

**Storage Area Network (SAN):** Specialized high-speed network dedicated to the transport of data between storage devices and servers

**Star topology:** Network topology in which services are distributed from or through a central point

**Telecommunications:** Transmission, emission, and reception of signs, signals, writings, images, and sounds, that is information of any nature by cable, radio, optical, or other electromagnetic systems

**Unshielded twisted pair (UTP):** Cable made up of one or more pairs of twisted copper conductors with no metallic shielding; the entire assembly is covered with an insulating sheath (cable jacket)

**Wireless access point:** Stand-alone hardware device or computer wireless adapter with software that acts as a wireless communication hub for users of wireless devices to connect with each other and to bridge those devices to the cabled portion of the network

**Wide area network (WAN):** Data communications system that uses telecommunications circuits to link LANs that are distributed over large geographic distances

**Wireless local area network (WLAN):** Data communications system that uses using radio frequency technology, such networks transmit and receive data over the air, minimizing the need for wired connections; they combine data connectivity with user mobility

**Work area (workstation):** Building space where occupants interact with telecommunications terminal equipment

**Work area cable (cord):** Cable connecting the telecommunications outlet/connector to the terminal equipment

### 1.06 PRE-CONSTRUCTION MEETINGS

A. Telecommunications subcontractor shall attend the pre-construction meeting as required by the Contractor or the Owner's Representative.

B. Provide a schedule, indicating installation tasks, time duration for each task and coordination items to be discussed 5 days prior to the meeting, to the Contractor and to the Owner's Representative.

### 1.07 MANUFACTURER CERTIFICATION

A. Structured cabling system shall be covered by an Extended Product and Application Assurance Warranty.
   1. Warranty shall cover passive telecommunications infrastructure copper and optical fiber connectivity and cabling products and performance from the date of installation registration, and will support existing or future applications.
   2. Approved manufacturer solution partner and warranty is:
      a. Berk-Tek/ Leviton Technologies – Limited Lifetime warranty
      b. CommScope Uniprise – 25 year warranty
   3. Installation practices shall follow the installation guidelines and procedures specified in the manufacturer certified installer training course and current TIA standards.
   4. Submit closeout documentation in accordance with the manufacturer warranty requirements to comply for acceptance of warranty.

B. Provide the original hard copy certificate for the Application Assurance Warranty to the Owner.

### 1.08 MATERIAL PROVISIONS

A. Deliver materials to the Owner under provisions of this section.

B. Contractor shall be responsible to provide a material transmittal for all materials being provided to the Owner as described herein and that are not permanently installed. Transmittal shall be signed by the Owner receiving the materials. Transmittal shall be included as part of the O&M manuals.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Substitutions: The substitution of products shall not be considered under the terms and conditions of this Section.

### 2.02 COPPER HORIZONTAL CABLING

A. Category 6 UTP cabling for interior spaces:
   1. Horizontal cables shall be constructed from 23 AWG insulated solid bare copper conductors formed into four individually twisted pairs with a crossfiller center spline.
   2. Conductors shall have an impedance of 100Ω ±10% / 100m.
   3. Cables shall meet the most current technical characteristics of TIA-568-C standard.
      a. Wire map
      b. Length
      c. Insertion loss (Attenuation) 32.6dB/100m @ 250MHz
      d. Near-end crosstalk (NEXT) loss 43.3dB/100m @ 250MHz
      e. Attenuation to crosstalk ratio far-end (ACRF) 24.8dB/100m @ 250 MHz

f. Power sum Attenuation to crosstalk ration far-end (PSACRF) 21.8dB/100m @ 250MHz
g. Power sum-near-end crosstalk (PS-NEXT) 41.3dB/100m @ 250MHz
h. Return loss (RL) 20.5dB/100m @ 250MHz
i. Propagation delay (PD) (CMP) 72% nom, (CMR) 68% nom
j. Delay skew (DS) 45ns/100m max
k. Balance (LCL/TCL) 27.0dB/100m @ 200MHz
l. Balance (EL-TCTL) 9.0dB/100m @ 200MHz

4. Cables shall be NFPA 262 CMP (plenum) rated as specified herein, unless otherwise noted. Cable diameter shall not exceed 0.23 inches.
   a. Manufacturer Berk-Tek LANmark-1000 series:
      1) Yellow plenum rated, Part No. 10032090
      2) Blue plenum rated, Part No. 10032094
      3) Gray plenum rated, Part No. 10032026
5. Cables shall be UL1666 IEC332-1 CMR (riser) rated as specified herein, unless otherwise noted. Cable diameter shall not exceed 0.23 inches.
   a. Manufacturer Berk-Tek LANmark-1000 series:
      1) Yellow riser rated, Part No. 10032461
      2) Blue riser rated, Part No. 10032455
      3) Gray riser rated, Part No. 10032452

B. Category 6 UTP outside plant cabling for underground and exterior spaces:
1. Horizontal cables shall be constructed from 23 AWG insulated solid bare copper conductors formed into four individually twisted pairs with a crossfiller center spline and enclosed by a UV resistant polyethylene in the color black. Cable shall contain a gel-filled water resistant flooding compound.
2. Cable diameter shall not exceed 0.25 inches.
3. Conductors shall have an impedance of 100Ω ±10% / 100m.
4. Cables shall meet the most current technical characteristics of TIA-568-C standard.
   a. Wire map
   b. Length
   c. Insertion loss (Attenuation) 32.8dB/100m @ 250MHz
   d. Near-end crosstalk (NEXT) loss 38.3dB/100m @ 250MHz
   e. Attenuation to crosstalk ratio far-end crosstalk (ACRF) 19.8dB/100m @ 250 MHz
   f. Power sum attenuation to crosstalk far-end crosstalk (PSACRF) 16.8dB/100m @ 250MHz
   g. Power sum-near-end crosstalk (PS-NEXT) 36.3dB/100m @ 250MHz
   h. Return loss (RL) 17.3dB/100m @ 250MHz
   i. Propagation delay (PD) 62% nom
   j. Delay skew (DS) 45ns/100m max
5. Cabling shall be utilized per the NEC for use where pathways are routed within or below building slabs and foundations, in outside plant underground pathways and for aerial applications.
   a. Manufacturer Berk-Tek LANmark-6 OSP, Part No. 10139885

C. Category 6 UTP UL Listed cabling rated for indoor/outdoor applications:
1. Cabling shall be utilized per the NEC for use where pathways are routed within or below building slabs and foundations.
2. Horizontal cables shall be constructed from 23 AWG PO (non-plenum) insulated solid bare copper conductors formed into four individually twisted pairs with a core separator.

3. Cabling shall be fully water blocked with a flooded core and shall have a black sunlight resistant jacket.
4. Cable diameter shall not exceed 0.271 inches.
5. Conductors shall have an impedance of 100Ω ±10% / 100m.
6. Cables shall meet the most current technical characteristics of TIA-568-C standard.
   a. Wire map
   b. Length
   c. Insertion loss (Attenuation) 32.6dB/100m @ 250MHz
   d. Near-end crosstalk (NEXT) loss 49/100m @ 250MHz
   e. Attenuation to crosstalk ratio (ACR) 6.7dB/100m @ 100MHz
   f. Power sum attenuation to crosstalk ratio (PS-ACR) 4.7dB/100m @ 250MHz
   g. Power sum-near-end crosstalk (PS-NEXT) 40dB/100m @ 250MHz
   h. Return loss (RL) 17.3dB/100m @ 250MHz
   i. Delay skew (DS) 25ns/100m max
7. Cabling shall be NEC rated CM for general purpose communications in accordance with Article 800 of the National Electrical Code (NEC.)
   a. Manufacturer Mohawk VersaLAN, Part No. M58772

## 2.03 OPTICAL FIBER HORIZONTAL CABLING

A. Horizontal 50/125 μm multimode optical fiber backbone cabling (OM3) shall be indoor/outdoor rated tight buffer cable utilizing a dry water blocking system with 900 μm buffered fibers surrounded by FGE/aramid yarns.
   1. Multimode optical fiber shall meet the following performance specifications.
      a. Maximum Attenuation: 3.0 dB/km @ 850 nm, 1.0 dB/km @ 1300 nm
      b. Minimum Bandwidth: Effective Model Bandwidth using Differential Mode Delay is 2000 MHz-km @ 850 nm; Overfilled launch is 500 MHz-km @ 1300 nm
      c. Gigabit Ethernet distances of 1000 m @ 850 nm, 600 m @ 1300 nm
      d. 10 Gigabit Ethernet distances of 300 m @ 850 nm, 300 m @ 1300 nm
      e. Numeric Aperture: 0.200 +/- 0.015
      f. Core Diameter: 50 +/- 2.5 μm
      g. Cladding Diameter: 125.0 +/- 1.0 μm
      h. Operating Temperature: -20C to +75C
      i. Storage Temperature: -40C to +85C
   2. Cable shall have an overall black color jacket and shall meet the following standards: Telcordia GR-409; ICEA S-104-696; ICEA S-83-596; ETL and OFNR (riser) rated as specified herein, unless otherwise noted.
      a. Manufacturer Berk-Tek, 2-strand riser rated, Part No. ATR002EB3010/25

## 2.04 INNERDUCT AND CABLE IDENTIFICATION TAGS

A. Textile Innerduct:
   1. Textile innerduct shall contain multiple flexible, polyester/nylon textile resin polymer fabric textile cells per innerduct as indicated on the Contract Drawings. Innerducts shall be installed within conduit raceways. Innerduct cells shall be the color white and shall have footage markers indicated on the side of the cell.
   2. Center spine of textile innerduct shall be installed in the color black or red when utilizing a 3-inch width. Black shall be the default color when only one set of innerduct is being installed within a conduit. Center spine of textile innerduct shall be installed in the color purple when utilizing a 2-inch width.

3. Cells within the textile innerduct shall contain a pull tape in differentiating colors. One cell shall have a pull tape in the color white, a second cell shall have a pull tape in the color white with a blue stripe and the third cell shall have a pull tape in the color white with an orange stripe.
    a. Manufacturer MaxCell:
        1) 2-inch, 2 cell with the color black spine, Part No. MXE52222BKyyyy (yyyy = length in feet)
        2) 3-inch, 3 cell with the color black spine, Part No. MXE64283BKyyyy (yyyy = length in feet)
        3) 3-inch, 3 cell with the color red spine, Part No. MXC64283RDyyyy (yyyy = length in feet)
4. Textile innerduct installation kits shall be provided for a single innerduct pack or multiple innerduct packs. Utilize an 1800 lbs. swivel device or a 2-way/ 3-way chain harness based upon the quantity of innerducts being installed within a conduit raceway.
    a. Manufacturer MaxCell:
        1) Single 1800 lbs. swivel, Part No. MXCSW600
        2) 2-Way chain pulling harness, Part No. MXC2CH
        3) 3-Way chain pulling harness, Part No. MXC3CH
5. Textile innerduct inflation termination bags shall be provided for each conduit. Inflation bags shall be provided in each outside plant conduit at the last maintenance hole that routes to either the associated telecommunications room or the exterior junction box on the building or structure. Inflation bags shall also be provided at the opposite end at the telecommunications room or the exterior junction box.
    a. Manufacturer MaxCell:
        1) 4-inch diameter Inflation Bag, Part No. MXCRTBVL100
        2) 3-inch diameter Inflation Bag, Part No. MXCRTBVL80
        3) 2-inch diameter Inflation Bag, Part No. MXCRTBVL50

B. Optical Fiber Flexible Plastic Innerduct:
1. Flexible duct/innerduct shall be UL 2024 with pull tape. Flexible duct/ innerduct shall be provided for all optical fiber cabling routed in open cabling pathways and backbone riser applications.
    a. Manufacturer Carlon:
        1) 1-inch plenum, Part No. CF4X1C-xxx (where xxx = feet)
        2) 1-1/4-inch plenum, Part No. CG4X1C-xxx (where xxx = feet)
        3) 1-inch riser, Part No. DF4X1C-xxx (where xxx = feet)
        4) 1-1/4-inch riser, Part No. DG4X1C-xxx (where xxx = feet)

C. Copper and Optical Fiber Identification Tags:
1. Identification tags shall be self-laminating, write-on, rigid, non-adhesive, measuring 3.50” x 2.00”, and with a vinyl material strength of 0.20”. Attach the tags to the associated innerduct or directly to the cabling utilizing specified cable ties. The legend and nomenclature for optical fiber cabling shall read “CAUTION: FIBER OPTIC CABLE” and for copper cabling shall read “CAUTION: TELEPHONE CABLE”. Each tag shall have sub attribute lines for “TYPE” and “COUNT”. The tag color for optical fiber cabling shall be yellow and the tag color copper cabling shall be orange.
    a. Manufacturer ACP International:
        1) Optical fiber cabling tags, Part No. VCT-200 (yellow)
        2) Copper cabling tags, Part No. VCT-201 (orange)

2. Cable tie shall be dome-top; barb type with stainless steel locking barb, material shall be Nylon 6.6 with a maximum width of .141".
    a. Manufacturer Panduit or equal:
        1) 6.1-inch length, Part No. BT1.5I-C0
        2) 8.0-inch length, Part No. BT2I-C0

## 2.05 TELECOMMUNICATIONS WORKSTATION DEVICES

A. Category 6 Modules:
1. 8-Position 8-Conductor modules shall be Category 6, dual reactance technology, non-keyed, universal T568A/B pin configuration standard and used to terminate Category 6 UTP cables as specified herein. Module shall be high impact plastic housing, flame retardant UL 94V-O, modular contacts shall be beryllium copper, nickel plating under 50 micro-inches gold plating in contact area. IDC contacts shall be phosphor bronze, nickel under plating with tin lead over plate serving 22 through 24 AWG.
    a. Manufacturer Leviton:
        1) Category 6 module:
            a) White, Part No. 61110-RW6
            b) Ivory, Part No. 61110-RI6
            c) Black, Part No. 61110-RE6
            d) Gray, Part No. 61110-RG6
        2) Blank module in package of 10:
            a) White, Part No. 41084-BW
            b) Ivory, Part No. 41084-BI
            c) Black, Part No. 41084-BE
            d) Gray, Part No. 41084-BG
2. Ivory color, Augmented Category 6, 8P8C modules and blank modules shall be provided for installation of modules in surface mounted raceway.
    a. Manufacturer Leviton:
        1) Category 6 module, Part No. 61110-RI6
        2) Blank module (pkg. of 10), Part No. 41084-BI

B. Wall Phone Faceplate with Studs:
1. Wall phone faceplates shall be stainless steel single gang plates with top and bottom phone studs for mounting of telephony handsets. Provide 8P8C module in the category of infrastructure specified for the structured cabling system.
    a. Manufacturer Leviton, Part No. 4108W-1SP

C. Faceplates:
1. Faceplate shall be thermoplastic or stainless steel manufactured to hold 8P8C modules with recessed designation strips with clear plastic covers in accordance with the TIA-606-B labeling standard.
    a. Manufacturer Leviton:
        1) 4-port thermoplastic:
            a) White, Part No. 42080-4WS
            b) Ivory, Part No. 42080-4IS
            c) Black, Part No. 42080-4ES
            d) Gray, Part No. 42080-4GS
        2) 6-port thermoplastic:
            a) White, Part No. 42080-6WS
            b) Ivory, Part No. 42080-6IS

c) Black, Part No. 42080-6ES
d) Gray, Part No. 42080-6GS
3) 4-port stainless steel, Part No. 43080-1L4
4) 6-port stainless steel, Part No. 43080-1L6

D. Surface Mount Boxes:
1. Surface mount boxes shall be thermoplastic to hold 8P8C modules with recessed designation strips with clear plastic covers in accordance with the TIA-606-B labeling standard.
a. Manufacturer Leviton:
1) 1-Port white, Part No. 41089-1WP
2) 1-Port ivory, Part No. 41089-1IP
3) 2-Port white, Part No. 41089-2WP
4) 2-Port ivory, Part No. 41089-2IP

E. Power Pole Bezel:
1. Bezel shall hold 8P8C modules and shall utilize a 106-type configuration.
2. Bezel shall be a color that matches the power pole; default color shall be Ivory.
a. Manufacturer Leviton, Part No. 41087-QIP

F. Floor Box and Poke-Thru Pedestal Frame:
1. Frame shall hold four 8P8C modules and shall utilize a Decora style configuration.
a. Manufacturer Leviton:
1) White, Part No. 41644-00W
2) Ivory, Part No. 41644-00I

**2.06 DIRECT CONNECT AND ALARM CONNECTIVITY**

~~A.~~ Direct Connect Connectivity and Terminations:
1. 8P8C Modular Plugs
a. Pre-approved Category 6 8-position, 8-conductor 8P8C plugs shall be provided based on the warranting manufacturer for the direct attach termination to solid conductor Category 6 cabling.
b. 8P8C plugs shall be compatible to be terminated on both Category 6 and Augmented Category 6 cabling.
c. 8P8C plugs shall be field terminated with manufacturer approved termination tool. No other termination tools shall be authorized for the termination of these direct attach terminations.
d. Plugs with a plastic boot shall be plenum rated when used in an air-plenum environment.
e. Adhere to manufacturer’s plug installation guidelines and testing procedures to ensure proper performance and signal transmission.
1) Category 6 8P8C plug approved manufacturers:
a) Bel Stewart, Part No. SS-39100-021
b) Sentinel, Part No. 111-08080054L34
c) Allen Tel, Part No. AT8X8RCSC-24
2) 8P8C termination tool approved manufacturers:
a) Bel Stewart, Part No. 2990003-01
b) Sentinel, tool & die set, Part No. 9000015 & 900216
c) Allen Tel, Part No. AT568 or AT680

B. Security Connectivity:
   1. RJ31X surface mount device shall be provided for the security intrusion alarm panel. Surface mount device shall be pre-wired 8-position, 8-conductor RJ31X with shorting bar and screw terminals.
   2. Device shall be mounted on wall/backboard adjacent to security panel or fire alarm panel. Route horizontal cabling from security device location to 110 cross-connect field in the telecommunications room. Terminate cable on last position of 110-field as noted on the drawing and label as “RJ31X”.
      a. Manufacturer Leviton, Part No. 40278-SBI

## 2.07 POWER DISTRIBUTION

A. Uninterruptible Power Supplies (UPSs):
   1. UPS shall provide standby emergency power to maintain a direct power source to support technology network equipment. Sizes and quantities of UPSs shall be indicated based upon applicable Contract Drawings.
   2. UPSs shall be rack mounted in either two post or four post equipment racks or server enclosures.
   3. UPS shall have the capability of providing environmental monitoring for temperature control and shall have a space to add a network interface card to provide performance monitoring on the Owner’s network.
   4. UPS unit shall have the capability for adding additional battery capacity for increased runtime. Provide additional backup batteries as indicated on applicable Contract Drawings.
   5. UPS shall be equipped and configured with a maintenance bypass to allow battery replacement to occur during standard operation without requiring a network outage.
   6. Coordinate voltage, amps, receptacle type and/or connection type with the electrical contractor.
      a. Manufacturer APC:
         1) 2.2kVA UPS w/network card, Part No. SRT2200RMXLA-NC
         2) 3kVA UPS w/ network card, Part No. SRT3000RMXLA-NC
         3) 2-post rail kit, Part No. AP9625 (per UPS)
      b. Pre-approved acceptable alternate manufacturers are Minuteman and TrippLite.

## 2.08 TELECOMMUNICATIONS ROOM CONNECTIVITY

A. Patch Panels:
   1. Category 6 Modular Patch Panels
      a. Category 6, 8-Position 8-Conductor module, non-keyed, dual reactance technology, 110 type printed circuit board style patch panels, universal T568A/B pin configuration standard and used to terminate UTP cables as specified herein. Patch panels shall be high density, 6-port modules, panel shall be14-gauge steel with black painted finish; module shall be high impact plastic housing, flame retardant UL 94V-O, and fully encased protected printed circuitry. Modular contacts shall be beryllium copper, nickel under plating, 50 micro-inches of gold in contact area with IDC contacts phosphor bronze, nickel under plating with tin lead over plate, serving 22 through 26 AWG.
         1) Manufacturer Leviton:
            a) 24 port patch panel, Part No. 69586-U24
            b) 48 port patch panel, Part No. 69586-U48

B. Wall Mount 110 Series Wiring Block:
   1. 110 wiring blocks shall be constructed of high impact fire retardant polycarbonate UL 94V-O molded plastic and shall contain extension legs. IDC contacts shall be phosphor bronze, 90/10 tin lead plating. Each kit shall include white horizontal identification strips that secure and organize 25 pairs each. For backbone cabling terminations, utilize 5-pair 110C connecting clips only. Each block shall include legs to allow back cable routing. The wiring blocks shall accommodate 22 through 26 AWG cable conductor size.
      a. Manufacturer Leviton:
         1) Category 5e 100-pair backbone kit, Part No. 41AB2-1F5
         2) Category 5e 300-pair backbone kit, Part No. 41AB2-3F5
         3) Category 5e 100-pair horizontal kit, Part No. 41AB2-1F4
         4) Category 6 96-pair horizontal, Part No. 41AB6-1F4

C. Optical Fiber Cabinets and Connectivity:
   1. Optical fiber cabinet shall be a termination and administration point for the optical fiber cables. Cabinets shall protect the connectorized optical fiber from mechanical stress, macro-bending loss at the connection point and tampering with the circuits.
   2. Surface Mount Fiber Cabinets (SMFC)
      a. SMFC shall provide cross-connect and inter-connect capabilities and include support hardware to properly terminate and route the optical fiber strands and patch cords in a wall field.
      b. SMFC shall have connector panels or adapters that can snap into the side of the interior vertical panel and accommodate optical fiber connectors.
      c. SMFC shall be made heavy constructed 16 gauge laser cut steel with optional double sided lock for additional security.
         1) Manufacturer Leviton:
            a) One adapter SMFC, Part No. 5WMNT-1C
            b) Two adapter SMFC, Part No. 5WSML-2C
            c) Four adapter SMFC, Part No. 5WMED-4C
            d) Lock and key, Part No. 5L000-KAL (Qty. 2)
   3. Rack Mount Fiber Cabinets (RMFC)
      a. RMFC shall accommodate terminating and splicing capabilities for optical fiber strands.
      b. RMFC shall be stackable, wall or rack mountable depending on the location requirement. The cabinets shall fit into either 19” or 23” frame arrangements and shall be one, two or four rack units in height.
      c. RMFC shall consist of an enclosure with front and rear access and can be fully administered from the front or rear.
      d. RMFC shall have a translucent, hinged Plexiglas door in the front and rear with sliding tray.
         1) Manufacturer Leviton:
            a) 1RU patching and splicing, Part No. 5R1UH-S03
            b) 2RU patching and splicing, Part No. 5R2UH-S06
            c) 4RU patching and splicing, Part No. 5R4UH-S12
      e. Fusion Splice Trays
         1) Fiber splice trays shall be offered with clear polycarbonate covers for viewing, and tie-down holes for securing incoming fiber. Trays shall accommodate 12 heat-shrink style splicing for both single-mode and multimode fiber.
            a) Manufacturer Leviton, Part No. T5LHS-P06

4. Optical Fiber Adapter Panels:
   a. Optical fiber adapter panels shall be located within surface mount and rack mount fiber cabinets. Panels shall securing lock into open positions with the patching frames. Panels shall have plunger / grommet fasteners.
   b. Optical fiber adapter panels shall consist of ST, LC or SC connector types and shall be configured in either simplex or duplex connector arrangements and indicated in the Contract Documents.
   c. Unfilled positions within the fiber cabinets shall contain blank panels.
      1) Manufacturer Leviton:
         a) Blank adapter panel, Part No. 5F100-PLT
   d. 50μm multimode optical fiber connectors shall be color aqua, with phosphor-bronze alignment sleeves.
      1) Manufacturer Leviton:
         a) 6-Duplex LC 50μm, Part No. 5F100-2QL
         b) 3-Duplex SC 50μm, Part No.5F100-6QC
         c) 6-Duplex SC 50μm, Part No.5F100-2QC
   e. 62.5μm multimode optical fiber connections shall be in the color beige, with phosphor-bronze alignment sleeves.
      1) Manufacturer Leviton:
         a) 6-Duplex LC 62.5μm, Part No. 5F100-2IL
         b) 3-Duplex SC 62.5μm, Part No.5F100-6IC
         c) 6-Simplex ST MM, Part No. 5F100-6MT
   f. Singlemode optical fiber connectors shall be in the color blue with ceramic alignment sleeves.
      1) Manufacturer Leviton:
         a) 6-Duplex LC SM, Part No. 5F100-2LL
         b) 3-Duplex SC SM, Part No. 5F100-6LC
         c) 6-Duplex SC SM, Part No. 5F100-2LC
         d) 6-Simplex ST SM, Part No. 5F100-6MT

## 2.09 OPTICAL FIBER CONNECTIVITY

A. Optical Fiber Fan Out Kits
   1. Buffer tube fan-out kits shall provide the means of field-install connectors on 250 μm coated fibers. Indoor kits shall have a 900 μm fan-out assembly that is color coded to match the fiber color scheme. The fan-out assembly shall be 47-inches in length.
      a. Manufacturer Corning:
         1) 6-fiber kit, Part No. FAN-BT47-06
         2) 12-fiber kit, Part No. FAN-BT47-12

B. Multimode Connectors
   1. Field installable multimode connectors shall be provided to terminate optical fiber cables from cable-to-cable, cable-to-equipment or equipment-to-equipment. Multimode connector shall contain a factory bonded fiber strand insert, ceramic ferrule and factory polished.
   2. Connector shall be capable of mounting on either 0.9 mm-buffered fiber or 3.0 mm cordage. Connector shall meet IEC standards for repeatability and have a locking feature to the coupler and assure non-optical disconnect.
      a. Manufacturer Leviton:
         1) LC 50 μm, Part No. 49991-LLC
         2) SC 50 μm, Part No. 49991-LSC

3) ST 50 μm, Part No. 49991-5ST
4) LC 62.5μm, Part No. 49991-MLC
5) SC 62.5μm, Part No. 49991-MSC
6) ST 62.5μm, Part No. 49991-MST

## 2.10 OPEN CABLING SUPPORTS

A. Accessories and mounting hardware shall be provided for securing supports to structure for a complete and working installation of open cabling supports. Supports shall comply with TIA requirements for structured cabling systems and pathway supports. Follow manufacturer's recommendations for quantity of cables supported.

B. Hook & Loop Fasteners:
   1. Hook and loop fastener rolls shall be offered in 15 and 75-foot lengths and be 0.5-inch in width. Shear strength; for plenum rated product shall be 29 PSI and non-plenum rated product shall be 23 PSI. Hook and loop fasteners installed in plenum air spaces shall be UL Listed (plenum) and be in the color maroon.
      a. Manufacturer Leviton or equal:
         1) Non-plenum 15' roll, Part No. 43115-15
         2) Non-plenum 75' roll, Part No. 43115-75
         3) Plenum 15' roll, Part No. 43115-15P
         4) Plenum 75' roll, Part No. 43115-75P

C. Circular Cable Retainer:
   1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
      a. Manufacturer Erico Caddy, Part No. CAT CR50

D. J-Hooks:
   1. J-hooks shall have a Galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
      a. Manufacturer Erico Caddy:
         1) 1" Dia., Part No. CAT16HP
         2) 1-5/16" Dia., Part No. CAT21HP
         3) 2" Dia., Part No. CAT32HP

E. Adjustable Cable Support:
   1. Adjustable cable supports shall be of steel and polyethylene, plenum rated, with unlocking and locking bar allowing additional cables to be added easily after installation.
      a. Manufacturer Erico Caddy, Part No. CAT425

F. Conduit Waterfalls:
   1. Waterfalls shall be of glass reinforced flame retardant nylon 6.6 and UL Listed for air handling spaces (plenum).
   2. Waterfalls shall be provided at the ends of 4-inch conduits and conduit sleeves installed horizontally where the pathways transition from conduit to ladder rack and cable tray pathways. Waterfalls shall be utilized to provide bend radius of all horizontal and backbone cabling.
      a. Manufacturer Panduit, Part No. CWF400

## 2.11 FIRE-RATED PATHWAYS

A. Fire-rated pathway device shall consist of a corrugated steel tube with zinc coating, contain an inner plastic housing, intumescent material rings and tightly twisted inner fabric smoke seal. Intumescent firestopping material shall automatically adjust to the size of the cabling bundle and shall permit cabling to be added or removed without the need to remove the firestopping material through the adjustment of the flanges and device threads at the ends of each sleeve. After the installation of the cabling, twist the inner fabric smoke seal so that it seals around the cabling. Length of the sleeve shall be 12.4 inches. The pathway device shall be UL tested and classified in accordance with ASTM E814 (UL1479).
   1. Manufacturer HILTI Speed Sleeve:
      a. 2-Inch fire-rated pathway device, Part. No. 2097882
      b. 4-Inch fire-rated pathway device, Part No. 2097883

B. Fire-rated pathway device shall consist of a heavy gauge galvanized steel raceway lined with intumescent firestopping material. The intumescent firestopping material shall automatically adjust to the size of the cabling bundle and shall permit cabling to be added or removed without the need to remove the firestopping material. Provide the necessary quantity of wall plates to support the pathway device. The pathway device shall be UL tested and classified in accordance with ASTM E814 (UL1479).
   1. On the 3-inch and 4-inch sleeves, provide radius control modules at the end of each sleeve through wall transitions and penetrations.
      a. Manufacturer Specified Technologies, Inc. EZ Path:
         1) 1.5-Inch fire-rated pathway device, Part No. EZD22
         2) 3-Inch fire-rated pathway device, Part. No. EZDP33FWS
         3) 3-Inch radius control module, Part No. RCM33
         4) 4-Inch fire-rated pathway device, Part No. EZDP44S2
         5) 4-Inch radius control module, Part No. EZRCM44S
         6) 4-Inch extension module, Part No. EZD44ES

C. Firestopping putty shall be a one-part, two-stage intumescent, non-hardening compound. The putty, when exposed to high heat or flame shall be capable of expanding a minimum of five times. Range of continuing expansion shall be from 230°F to >1,000°F (110°C to >538°C). The putty shall be soft and pliable with aggressive adhesion and shall not contain any water-soluble intumescent ingredients. The putty shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
   1. Manufacturer Specified Technologies, Inc. SpecSeal:
      a. 24” putty bar, Part No. SSP28
      b. 36” putty bar, Part No. SSP100

## 2.12 MATERIAL PROVISIONS

A. Materials shall be provided to the Owner as specified herein. Deliver to the Owner Representative 21 days prior to Substantial Completion. Include a signed transmittal to the Owner or Owner’s Representative for each type of patch cord, quantity, length, and color provided as part of the Final Acceptance.
   1. Copper Patch Cords

      a. Category 6 Patch Cords
         1) Patch cords shall be constructed from Category 6 4-pair 24 AWG, stranded patch cable material.
         2) Patch cord cable assembly shall be UL✹ listed and meet FCC Part 65 plug and termination.

| Item | Manufacturer | Part Number | Qty. | Length | Color | Description |
|---|---|---|---|---|---|---|
| 1 | Leviton | 6D460-3L | | 3'-0" | Blue | Data |
| 2 | Leviton | 6D460-5L | | 5'-0" | Blue | Data |
| 3 | Leviton | 6D460-7L | | 7'-0" | Blue | Data |
| 4 | Leviton | 6D460-10L | | 10'-0" | Blue | Data |
| 5 | Leviton | 6D460-07W | | 7'-0" | White | Workstation |
| 6 | Leviton | 6D460-10W | | 10'-0" | White | Workstation |
| 7 | Leviton | 6D460-3E | | 3'-0" | Black | Data |
| 8 | Leviton | 6D460-5E | | 5'-0" | Black | Data |
| 9 | Leviton | 6D460-7E | | 7'-0" | Black | Data |
| 10 | Leviton | 6D460-10E | | 10'-0" | Black | Data |
| 11 | Leviton | 6D460-3Y | | 3'-0" | Yellow | Data |
| 12 | Leviton | 6D460-5Y | | 5'-0" | Yellow | Data |
| 13 | Leviton | 6D460-7Y | | 7'-0" | Yellow | Data |
| 14 | Leviton | 6D460-10Y | | 10'-0" | Yellow | Data |
| 15 | Leviton | 6D460-3R | | 3'-0" | Red | Wireless |
| 16 | Leviton | 6D460-5R | | 5'-0" | Red | Wireless |
| 17 | Leviton | 6D460-7R | | 7'-0" | Red | Wireless |
| 18 | Leviton | 6D460-10R | | 10'-0" | Red | Wireless |

2. Optical Fiber Patch Cords
   a. Multimode Patch Cords (OM3)
      1) Optical fiber patch cords shall be 50/125 μm with metal ferrules, constructed from OFNR rated dual fiber cordage, in the color aqua.

| Item | Manufacturer | Part Number | Qty. | Length | Color | Description |
|---|---|---|---|---|---|---|
| 1 | Leviton | 5LDSC-M01 | | 1M | Aqua | SC – SC |
| 2 | Leviton | 5LDSC-M02 | | 2M | Aqua | SC – SC |
| 3 | Leviton | 5LDSC-M03 | | 3M | Aqua | SC – SC |
| 4 | Leviton | 5LDLC-M01 | | 1M | Aqua | LC – LC |
| 5 | Leviton | 5LDLC-M02 | | 2M | Aqua | LC – LC |
| 6 | Leviton | 5LDLC-M03 | | 3M | Aqua | LC – LC |
| 7 | Leviton | 5LDCL-M01 | | 1M | Aqua | LC – SC |
| 8 | Leviton | 5LDCL-M02 | | 2M | Aqua | LC – SC |
| 9 | Leviton | 5LDCL-M03 | | 3M | Aqua | LC – SC |

## PART 3 EXECUTION

### 3.01 ADDITIONAL CABLING

A. Provide an additional 12 Category 6 cables to be located during construction by the Owner. Workstation devices shall be as specified herein including but not limited to; cabling, faceplates, modules, blank modules, open cabling supports, labeling and testing.
   1. Assume an installed cable length of 295'.

## 3.02 GENERAL

A. Include labor, materials, tools, equipment and services for installation as indicated on the Contract Documents.

B. Coordinate Work with other trades for complete and operational system.

C. Include supplementary and miscellaneous items, appurtenances, and devices incidental to and necessary for sound, secure, and complete installation, whether or not specifically indicated in the Contract Documents.

D. Provide suitable barriers and take any other safety precautions required by applicable codes.

E. Work area shall be kept free from debris of all types and remove all rubbish resulting from their work on the premises. Upon completion, vacuum and clean room floors, equipment racks, enclosures and cable management where work has been performed.

F. Contractor shall be responsible for any building repairs made necessary by their work or caused by negligence of their employees. No cutting, notching, drilling or altering of any kind shall be done to the building without first obtaining permission from the Owner.

G. Owner may have other contracts in connection with this work for the installation of software and equipment. Contractor shall provide other Trade Contractors reasonable opportunity for the introduction and execution of their work and shall properly coordinate other trade's work with theirs as required.

H. Provide patch panels and blocks indicated on the telecommunications drawings whether or not they are fully populated with cables.

I. Provide cables, devices and equipment racking systems as indicated on the Contract Drawings.

## 3.03 ABANDONED CABLING

A. Contractor shall be responsible for the demolition, removal and disposal of all existing abandoned telecommunications cabling and infrastructure in its entirety per NEC Article 800 and as identified on the Contract Drawings. Abandoned cabling shall be defined as any telecommunications cabling that is not terminated at both ends at a module or other equipment and is not identified for future use with a tag.

B. Telecommunications cabling and infrastructure shall include but not limited to, faceplates, surface mount boxes, RJ11 and 8P8C modules, horizontal UTP cabling, copper and optical fiber backbone infrastructure, innerduct, cabling support systems, equipment racks, horizontal and vertical cable management, equipment shelving, ladder tray, dedicated telecommunications surface raceway, 110 and 66 blocks, rack mount and surface mount fiber cabinets and other related passive infrastructure.

C. Provide blank cover plates for demolished flush mount outlets, surface mount boxes; modular furniture feed locations, and junction boxes.

D. Provide blank cover plate for demolished modular furniture telecommunications devices. Match modular furniture manufacturer system, make and base channel color.

E. Provide new cover plates for surface mount raceway systems after demolition of existing devices. Cover plate sections shall be seamless between new devices. Cover plates shall match existing base color.

F. Provide fire stopping of existing horizontal and vertical conduit sleeve, after existing horizontal and backbone cabling has been demolished. Provide fire stopping of existing wall penetrations. Seal all penetrations with approved fire stopping materials.

G. Provide (2) pull strings in each vertical conduit riser sleeves at the completion of demolition of existing cabling.

**3.04 OPEN CABLING SUPPORT INSTALLATION**

A. Cabling shall be run exposed as "open cabling" in ceiling spaces and ceiling plenums, unless otherwise noted.

B. Provide all hanger supports and cable supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.

C. Cabling supports shall be spaced no further than 4’-0" apart.

D. Cabling bundles shall not sag a maximum of two inches from the bottom of the cable support.

E. Provide all additional cable management products as required to protect exposed cabling and complete the installation of cabling in a neat professional manner.

F. Floor penetrations shall be at columns, exterior walls unless otherwise specified.

G. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.

H. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.

I. Cabling bundles and supports changing pathway direction shall maintain proper bend radius as to not impact the physical jacket construction of the cabling. Cabling that becomes damaged during this transition shall be replaced in its entirety.

J. Follow manufacturer’s recommendations for quantity of cables supported in J-hooks and adjustable cable supports.

K. Installers shall observe the applicable requirements and recommended good practices contained within TIA-568-C standard for cabling installation requirements.

**3.05 CABLING INSTALLATION**

A. Telecommunications devices shall be connected to the horizontal cross-connect in a telecommunications room with horizontal cabling installed in star topology.

B. Horizontal cabling shall be installed in continuous runs from the telecommunications rooms to telecommunications device locations. Splices are not permitted.

C. Maximum length of horizontal cables shall be 295 feet (90 m) including all service loops.

D. Cabling shall be installed in accordance with manufacturer’s recommendations, including but not limited to maximum tensile loading and maximum bend radius.

E. Cabling shall be organized and identified so as to facilitate locating and handling individual sheaths for maintenance functions.

F. Bundles shall be neatly secured without cinching or stressing the cabling, using hook and loop fasteners in open cabling installations and in the telecommunications room. Hook and loop fasteners shall be loose enough so that the fastener can be easily rotated around the cabling bundle and does not impact the physical construction of the cabling.

G. Provide machine typed label on both ends of the horizontal cabling jacket no more than 4-inches from each termination point.

H. Great care shall be taken to protect all cabling from physical damage beneath floors, above ceilings or elsewhere. Cabling shall not be exposed to any forces or handling factors that will degrade performance, such as crushing, pull stressing, twisting, or damaging sheathing materials. When left unattended, all cabling shall be secured and protected to avoid damage.

I. Hook and loops fasteners shall be utilized in the telecommunications room for all cabling bundles. Tie wraps are prohibited in the telecommunications rooms and spaces.

J. A spare pull string shall be installed at every outlet installed.

K. Horizontal and backbone cabling shall be bundled and routed separately in dedicated cabling supports in a neat and organized fashion for routing from the telecommunications rooms utilizing cable trays and open cabling pathways to the telecommunications devices.

L. Route cabling runs from workstations parallel to building grid lines and directly to open cabling pathways without passing over adjacent office spaces or cubicles.

M. Provide 5 feet of slack in neatly suspended loops above each workstation and 10 feet of slack neatly coiled in the ladder rack or cable tray in the telecommunications room unless indicated otherwise on Contract Drawings. Service loops in the telecommunications room shall not be located above the equipment racks and server enclosures.

N. Cables shall contact only dedicated and properly protected cable accesses and support mechanisms.

O. Telecommunications unshielded twisted pair cabling supported utilizing open cabling methods shall maintain a minimum separation of three inches from fire alarm, intercom/paging, clocks and security cabling. Cabling supports shall maintain increased separation requirements when attaching to the same hanger rod to ensure cabling sag maintains the minimum three inch separation.

P. Maintain the following distances between cabling and other building systems:
   1. One foot from fluorescent lights.
   2. Six feet from motors and transformers.
   3. Three feet from water piping or other mechanical equipment.
   4. One foot from electrical conduits or other electrical equipment.

## 3.06 CONNECTIVITY AND CABLING INSTALLATION

A. Cabling shall be dressed and terminated in accordance with the cabling installation requirements identified in TIA-568-C, BICSI Telecommunication Cabling Installation Manual, and the manufacturer’s documentation.

B. Cabling entering the telecommunications room and routing on the ladder rack or cable tray pathway shall be separated into cabling bundles specific to the patch panel in which it will be terminated to. Cable bundles shall be in increments of 24 cables.

C. Cabling shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the equipment rack, enclosure or backboard.

D. Cabling transitioning from ladder rack or cable tray pathway shall maintain proper bend radius utilizing waterfall device brackets for transitioning vertically down the side rail of an equipment rack or server enclosure as to not impact the physical jacket construction of the cable. Waterfall device brackets shall also be utilized for transitioning cabling to blocks mounted on plywood. Cabling that become damaged during this transition shall be replaced in their entirety.

E. Cables shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support straps. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

F. Installation of 8-position 8-conductor modular jacks into faceplates and attaching of the faceplates to the wall shall ensure that the faceplates are flush. The faceplate shall be secured to the wall but shall not be secured to the wall with such force as to bow the faceplate.

## 3.07 WORK AREA

A. 4-pair UTP horizontal cabling shall be terminated on an 8-position 8-conductor modular jack or plug at each telecommunications device as indicated on the applicable Contract Drawings.

B. Telecommunications devices shall be provided with 8-position 8-conductor modular jacks or plugs in the quantity as indicated on the applicable Contract Drawings.

## 3.08 CABLING TERMINATIONS

A. Provide all necessary installation materials, tools and equipment to perform insulation displacement type terminations at all the telecommunications outlets, patch panels and 110 cross-connect blocks.

B. Pairs in each cable shall be terminated on a 110 block, modular patch panel or telecommunications modules in accordance with this specification.

C. Cabling shall be terminated in accordance with the T568B pin configuration standard.

D. Remove only as much of the cable sheath as is necessary to terminate the cabling on the connecting hardware.

E. A maximum of 0.25” of cable pair twists shall be removed from a 4-pair UTP cable. Cabling and terminations exceed these dimensions shall be re-terminated.

F. At the horizontal station patch panel, the cabling shall terminate from the center of the 110 IDC termination.

G. Terminate cabling in accordance with connecting hardware manufacturer’s recommendations. All cabling shall terminate in numerical sequence.

## 3.09 FIRESTOPPING

A. Firestop systems shall be installed in accordance with the NEC and the manufacturer’s recommendations and shall be accomplished in a manner acceptable to the local fire and building authorities having jurisdiction over this work.

B. Cabling running through rated floors and walls shall be firestopped in accordance with the requirements within this Section.

C. Penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure).

D. Penetrations created by or for the contractor and left unused shall also be sealed as part of the contractor's scope of work.

E. Firestop putty or pillows shall be used inside conduits to provide a re-enterable system allowing telecommunications cables to be easily removed or added in the future. Firestop putty shall not be water soluble.

F. Firestop systems shall be UL Classified to ASTM E814 (UL 1479).

G. Firestopping sleeved devices shall be installed according to the manufacturer's recommendations including, but not limited to;
   1. Wiring devices shall be installed in locations where indicated on the Contract Drawings, arranged in a single or multiple sleeve formation at the height specified. Sleeves shall be installed a minimum of 6 inches above the accessible ceiling grid.
   2. Install the devices in strict accordance with the approved shop drawings and the manufacturer's recommendations.
   3. Apply the factory supplied gasket material prior to the installation of the wall plates.
   4. Secure wall plates to devices per the equipment manufacturer's recommendations.

## 3.10 INSTALLATION OF OPTICAL FIBER CABLING SYSTEM

A. Installation for Optical Fiber Cabling:
   1. Follow cable manufacturer's specifications regarding handling methods, bend radius and maximum pulling tension limitations.

B. Securing Fiber Cabling:
   1. Immediately after cabling installation, a permanent identification tag as indicated shall be attached to visible cabling sections. Cabling shall be checked to ensure that the markings are intact.
   2. Cabling and equipment shall be supported and secured as indicated. Where the specific method of support is not indicated, supports and fasteners shall be used to secure cabling and equipment in position. Metallic supports and fasteners shall have a corrosion resistant finish. All cabling shall be routed along the interior sides of manholes.
   3. Corrosion resistant clamps and straps shall be used as necessary to properly secure the cabling.
   4. Optical fiber cabling shall be secured to the optical fiber cabinet using the aramid strength yarn of the cabling to provide strain relief.

C. Optical Fiber Cabling Bending:
   1. Caution shall be used when bending cabling to avoid kinks or other damage to the sheath. Bend radius shall be as large as possible with a minimum of 20 times the cabling diameter. Minimum radius shall be increased when necessary to meet cable manufacturer's recommendation. Cabling shall not rest against any sharp edges.

D. Optical Fiber Cabling Pulling:
   1. Pulling lines shall be attached to both cable ends when cabling is destined for bi-directional pull, and fitted with factory-installed pulling eyes where possible. Cabling not equipped with a pulling eye shall have the pulling line attached to the cable end by means of a cable grip. Core hitches shall not be used.

2. Cable reels shall be located and aligned so that the cable is payed out from the top of the reel by rotating the reel in the feed direction at the rate of pull into the duct or conduit in a long, smooth bend without twisting. Cabling shall not be payed out from the bottom of the reel or by pulling. A cable feeder guide of proper dimensions shall be used at the mouth to guide the cable into the duct or conduit.
3. Rigging shall be set up at the pulling end so that the pulling line and cable exit on a line parallel with the duct or conduit to prevent either from rubbing against the edge or mouth. Cable ends shall not be pulled around sheave wheels. When the sheave or pulley cannot be positioned to obtain sufficient cable end slack for proper racking and splicing with the pulling line attached to the end of the cable, a split cable grip may be used to obtain the necessary slack.
4. Equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cabling shall be payed out without stopping until the required amount of the cabling has been placed. If the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cabling shall be overcome by increasing the tension in small steps a few seconds apart until the cabling is in motion.
5. Pulling tension shall not exceed 500 lbs. or cable manufacturer's recommendation, whichever is less.
6. Provide a 20’ foot service loop for all optical fiber cabling located at both ends of the cabling run in all telecommunications rooms and in utility vaults. Service loop shall be attached to the fire retardant plywood backboard and shall not be located on the ladder rack or cable tray.
7. Do not pull optical fiber cables with copper cables.
8. Do not pull optical fiber cables over existing cables.
9. When pulling optical fiber cabling in an innerduct or conduit, do not exceed the 40% fill ratio.

E. Optical Fiber Cabling Terminations:
1. Cable terminations shall be made in optical fiber distribution units. All installed optical fiber strands shall be terminated.
2. Optical fiber cabling terminations shall utilize enclosures and components in quantities consistent with the required fiber counts at each end of each segment. During optical fiber connector termination and polishing, visually inspect all terminations with a 400-power microscope. Follow all of the connector manufacturer’s recommendations. Unacceptable flaws in the terminations will include, but not limited to, scratches, full or partial cracks, bubbles, pits, epoxy residual, dirt, dust, oil, moisture, grinding and sanding debris. The acceptable final polish will show a connector tip that is free of all imperfections in 100% of the core and 80% of the cladding. All unacceptable connectors shall be inspected after rework.
3. Optical fiber cabling slack shall be neatly coiled within the optical fiber cabinet. No slack loops shall be allowed external to the optical fiber cabinet.
4. Cables shall be clearly labeled at the entrance to the fiber adapter panel.
5. To maintain the correct polarity throughout the optical fiber cabling system, each cabling segment shall be installed in a pair-wise crossover orientation as defined in TIA 568-C.
6. Dust caps shall be installed on the connectors and couplings.

## 3.11 LABELING

A. General:
1. Labeling shall be in accordance with TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure.
2. Labels shall be permanent typewritten labels produced by a labeling machine.

3. Labels shall be installed on all cabling at each end. Ensure labels are securely fastened.
4. Labels shall be located within 6 inches of cable termination and placed so they can be easily read.
5. Font type for each type of label shall be Arial with maximum size font allowed.
6. Labeling information will be reviewed at the Pre-Construction Meeting.
7. Labeling shall be completed prior to the Substantial Completion date of the project.

B. Telecommunications Device Labeling:
   1. Label shall be produced to fit into the recess provided and covered with a clear plastic cover.
      a. ##-TR1A-2-03-04 where:
         1) ## = Building number
         2) TR = Telecommunications Room (MC, IC, HC or as indicated on the Contract Drawings)
            a) TR(1) = Floor Number
            b) TR1(A) = Telecommunications room where multiple TRs exist on a floor. Letter designation shall occur from West to East for the locations of the TR.
         3) –2 = Equipment rack number
         4) –03 = Patch panel number
         5) –04 = Port number
   2. Above Ceiling Device Labeling
      a. A label on the ceiling grid shall be provided at each location where a network device is located above the ceiling. The label shall be machine generated. The text shall be in bold white letters on black background printed on 3/4” tape with the maximum font size allowable.
      b. Labeling shall be as follows:
         1) ‘*WAP*’ - TR-2-03-04 where:
            a) WAP= Device type as indicated on the Contract Drawings
            b) TR-2-03-04=Cable ID Label

C. Equipment Rack Labeling:
   1. Plastic lamacoid nameplate shall be provided for each equipment rack and/or server enclosure in the telecommunications room.
   2. Plastic lamacoid nameplate shall be black with white letters. The nameplate shall be machine engraved with a size 36 font.
   3. Mount the name plate at the top of each equipment rack, server enclosure or wall mount enclosure.
   4. Labeling scheme shall be as indicated on the Contract Drawings.

D. Patch Panel Labeling:
   1. Station Patch Panel
      a. 48-port modular patch panels shall be labeled with sequential numbering starting with “01” for the topmost patch panel and moving downward to the bottom of the rack. Patch panel labels shall be affixed to the left hand side of the patch panel.
      b. Horizontal cabling distributed from station patch panels to specialty devices (i.e. wireless access points, security devices and IP intercom speaker digital clocks) shall have a label in the designation strip space directly below the 8P8C module identifying the device interconnect point, the designation label shall be as follows:
         1) “WAP - #”, where the “#” represents the Owner’s wireless access point identification number.

2) "CAM - #", where the "#" represents the Owner's security video camera identification number.
3) "AC - #", where the "#" represents the Owner's IP Access Control room/space identification number.

E. Rack Mount Fiber Cabinet Labeling:
1. RMFC shall be labeled with sequential numbering starting with "FC1" for the topmost fiber cabinet and moving downward to the bottom of the rack. Labels shall be affixed to the left hand side of the RMFC.

F. Optical Fiber Termination Labeling
1. Labeling shall be placed within the designation strip holder of the fiber connector panel where designation strips are provided with the connector panel.
2. Labeling shall be placed on the inside of the front door for surface mount fiber cabinets and rack mount fiber cabinets where no designation label strips are provided. The label shall be in the same orientation of the connector panel.
3. Labeling shall contain the originating telecommunications room designation, rack row if applicable, equipment rack number designation, rack mount fiber cabinet number, fiber adapter panel position(s) and the associated fiber strand numbers by individual strands and/or optical fiber subunit classification.
4. Main Cross-connect will have labeling associated for the distribution of optical fiber cabling to each telecommunications room and the telecommunications room (IC or HC) will have labeling associated from the Main Cross-connect.
5. Backbone Optical Fiber Labeling:
a. Labeling shall be as follows in the originating telecommunications room:
1) HC1.A:1-6 where:
a) HC1 = telecommunications room
b) .A = Connector panel position
c) :1-6 = Strand numbers per connector panel
b. Labeling shall be as follows in the originating telecommunications room:
1) MC.A:1-6 where:
a) MC = Telecommunications room
b) .A = Connector panel position
c) :1-6 = Strand numbers per connector panel
6. Horizontal Optical Fiber Labeling:
a. Labeling shall be as follows at both ends:
1) MC.A:1-2 CAM.# where:
a) MC = Telecommunications room
b) .A = Connector panel position
c) :1-2 = Strand numbers per device
d) CAM.# = Device name and number

G. Cable Identification Tag Labeling:
1. Optical fiber and copper backbone cabling shall be clearly and visibly identified by the contractor in all manholes, pull boxes, riser room pull points, entrance points, service entrance and 3' before entering a free standing rack, wall mounted enclosure or surface mount fiber cabinet utilizing an optical fiber cable identification tag.
2. Optical fiber and copper backbone cable identification tags shall contain the following information at a minimum.
a. Cable manufacturer and part number
b. Extent of cable run (i.e. "From: MC – To: HC1A")

c. Cable type and description (i.e. “In/Outdoor Loose Tube, OM3 12-strand”)

## 3.12 TESTING

A. Test procedures shall be as prescribed by the TIA, Insulated Cable Engineers Association and the National Electrical Testing Association.

B. Test Equipment:
   1. Network testing equipment shall be a Fluke Networks DSX-5000 Cable Analyzer or equal and shall have a certified calibration from the manufacturer within the past 12 months at the time of testing. Proof of calibration shall be provided with the product submittal. Test equipment shall be utilized to test horizontal and backbone cabling.
   2. Field tester and adapters shall be certified by an independent laboratory as meeting or exceeding current level as defined in TIA-1152 Level IIIe.
   3. 8P8C test plug for the network testing equipment adapters shall be in range of values defined in Annex C with TIA-568-C for Near-end Crosstalk, Far-end Crosstalk and Return Loss.
   4. Test equipment shall support the complete suite of Resistance Unbalanced standards for PoE per IEEE 802.3af, IEEE 802.3at and TIA-568-C.2.
   5. Test equipment shall be able to test up to a 1000 MHz frequency range.
   6. Test equipment shall be ISO 9001 certified.
   7. An electronic copy of the manufacturer’s testing procedures shall be kept in the job site office.
   8. Test equipment batteries shall be charged daily and a level of greater than twenty-five percent of capacity shall be maintained during the testing.
   9. Test equipment shall be calibrated daily before the start of testing.

C. Horizontal Cabling:
   1. Horizontal cabling shall be certified to meet or exceed the permanent link performance specifications for Category 6 horizontal cabling tested with a frequency range from 1MHz to 250 MHZ as defined in TIA-568-C.
   2. Certifications shall include the following parameters for each pair of each cable installed:
      a. Building identification
      b. Cable identification
      c. Date of test
      d. Test equipment manufacturer and model number
      e. Wire map
         1) Continuity to the remote end.
         2) Shorts between any two or more conductors
         3) Reversed pairs
         4) Split pairs
         5) Transposed pairs
         6) Any other miswiring
      f. Length
      g. Near-end crosstalk (NEXT)
      h. Attenuation to crosstalk ration far-end (ACRF)
      i. Power sum Attenuation to crosstalk ration far-end (PSACRF)
      j. Power sum-near-end crosstalk (PS-NEXT)
      k. Return loss (RL)
      l. Propagation delay (PD)
      m. Delay skew (DS)

3. Horizontal cabling shall be tested using a Permanent Link configuration as defined in TIA-568-C.
4. Test reports with an asterisk (*) or fails, shall be documented identifying the reason for the test failure and a corrective action plan developed.
5. After corrective action has been completed, the permanent link shall be retested.
6. It is the Telecommunications Contractor's responsibility to ensure 100 percent of the network horizontal cabling system links pass all tests.
7. Test results shall be organized by building identification and cable identification number. The test results shall contain the date and time of when each test was saved in the memory of the tester. The test results shall be recorded on a flash drive in both PDF and LinkWare software formats.

D. Backbone 100 ohm UTP Cabling:
1. Continuity tests shall be performed on all backbone cabling pairs and/or conductors.
2. Testing procedures shall include the following parameters for each pair of each cable installed:
   a. Wire map
      1) Continuity to the remote end.
      2) Shorts between any two or more conductors
      3) Reversed pairs
      4) Split pairs
      5) Transposed pairs
      6) Any other miswiring
   b. Length
3. Tests shall be recorded as pass/fail as indicated by the test set in accordance with the manufacturers recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number.
4. Cabling links that fail the testing will be documented, identifying the reason for test failure and a corrective action plan.
5. After corrective action has been completed, the link shall be retested.

E. Optical Fiber:
1. Acceptance Testing
   a. Optical fiber test jumper shall be properly cleaned at both ends prior to the start of testing for each backbone segment.
   b. A reference power measurement shall be obtained by connecting one end of test jumper 1 to the light source and the other end to the power meter tester. After recording the reference power measurement, test jumper 1 shall be disconnected from the power meter tester without disturbing the light source and attached to the cable plant. The power meter tester shall be moved to the far end of the cable plant and attached to the cable plant with test jumper 2.
   c. Multimode optical fiber attenuation shall be tested and recorded at a minimum of three times on all individual fiber strands of each cable using the power meter tester configuration to determine the actual loss and the connector repeatability. Each of the three tests shall be recorded and a final value with the average of the three tests shall also be recorded. The connector repeatability shall not exceed 0.2 dB as defined by Telcordia GR-326-CORE. These tests shall be performed at the 850nm and 1300nm windows in bi-directional testing. Test set up and performance shall be in accordance with TIA/EIA-526-14A, Method B, and TIA-568C.0.
   d. After terminating optical fiber cabling, one of the individual fibers of each cable segment shall be tested using an OTDR to determine the actual length. One strand of each optical fiber buffer tube shall be tested with an OTDR.

### 3.13 PATCH CORD INSTALLATION SUPPORT

A. Provide installation of the copper and optical fiber patch cords between the active network electronics, horizontal station patch panels and voice cross-connect patch panels.
   1. Coordinate with the owner for patching and switch requirements.
   2. Contractor shall request the port identification patching matrix from the Owner in writing a minimum of three weeks in advance of starting the patch cord installation.

B. Patch cords shall be routed in a neat and orderly fashion, maintaining proper bend radius of the patch cords as to not decrease the system performance. Utilize horizontal and vertical cable management, including all bend radius support attachments to their fullest extent.

C. Horizontal cable management panels that contain small retainer clips at the top and bottom of the panels, a maximum of three patch cords shall be held within the retainer clips when interconnecting into patch panels or network switch ports.

D. Patch cords with sufficient length shall be utilized as to not damage or stretch the cable jacket but the lengths shall not be more than 18 inches in excess length stored within the vertical cable management.

E. Patch cords shall be routed horizontally in the cable management panels and transition upward and downward within the vertical cable management sections. Patch cords shall not be dressed top to bottom on the fronts of the equipment racks.

F. For bidding and installation purposes, assume a total of 36 copper patch cords and 3 optical fiber patch cords to be installed within the project site.

G. At the completion of the patch cord installation, provide an updated port identification patching matrix, in Microsoft Excel format, indicating the network switch number, switch blade number and switch port number that the patch cords interconnect occurred from the horizontal station patch panel. Provide a column indicating specific function uses of the switch port. Coordinate the specific function identifications and classifications with the Owner and Owner's Representative prior to the start of the installation.

**END OF SECTION**

Use the following table to track the installation of the additional workstation cabling as described in Paragraph 3.1.A.

| Port Qty. | Room Name | Room No. | Date of Install |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
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| | | | |
| | | | |

| Port Qty. | Room Name | Room No. | Date of Install |
|---|---|---|---|
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| | | | |

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: The following sections apply to Work in this Division:

1. Section 260500 General Electrical Provisions
2. Section 260510 Basic Electrical Materials and Methods
3. Section 260511 Electrical Connections for Equipment
4. Section 260512 Electrical Demolition
5. Section 260519 Wire and Cables
6. Section 260529 Supporting Devices
7. Section 260533 Raceway Systems
8. Section 260548 Vibration Isolation and Seismic Control for Electrical Systems
9. Section 260553 Electrical Identification
10. Section 260534 Outlet Boxes

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. This section is part of each Division 28 section.

B. The Drawings and General Provisions of the contract, including the General and Supplemental Conditions, Division 01 Specification sections, and all Division 27 & 28 sections, apply to work of this section.

C. See Specification Section 280000 For Division 28 related work specified in Division 26.

### 1.02 DESCRIPTION OF WORK

A. It is the intent of the sections in Division 28 to specify these systems:

| | Description | Section |
|---|---|---|
| a. | Security Control System | 280100 |
| b. | General Provisions | 280101 |
| c. | Security Electronics Demolition | 280102 |
| d. | Access Control System | 281300 |
| e. | Racks and Enclosures | 280530 |
| f. | Security Video System | 282300 |
| g. | Programmable Logic Controller | 284619 |
| h. | Touchscreen Control System | 284620 |
| i. | Security System Operations | 284621 |
| j. | Intercommunication System | 285010 |

B. The security related work of Division 28 shall be completed by a single Security System Integrator (SSI) firm meeting all of the qualifications requirements specified herein. SSI shall perform all the work specified in Division 28 with their own licensed forces. The only permissible subcontractors shall be an electrical subcontractor for the installation of electrical wire and conduit and a telecommunications cabling subcontractor.

C. Provision of conduit, raceways, enclosures, backboxes, backboards, wiring, and cable is included under Division 28. The Contractor shall closely coordinate with all divisions of work on the project to ensure placement of all required conduits, boxes, outlets, security hardware, power outlets, and other items required for proper operation of the security systems.

D. Division 28 is responsible for all Ethernet raceways and cabling required by Division 28. All security Ethernet raceways shall comply with EIA/TIA requirements.

E. All low-voltage and line-voltage wiring and devices for Division 28 systems shall be provided.

F. Security control system work shall be in complete accord with the following:
1. National Electrical Code (NEC)
2. Regulations of the State Fire Marshal
3. National Fire Protection Association (NFPA) Codes
4. All State and local codes and ordinances
5. UL Standards

## 1.03 QUALIFICATIONS OF THE SECURITY SYSTEM INTEGRATOR FIRM AND KEY PERSONNEL

A. The Security System Integrator (SSI) shall meet each of the qualifications criteria specified as of the date of bid submission. By submitting a bid for the Division 28 work the bidder holds himself out to be fully qualified in accordance with the criteria specified herein, without exceptions unless approved in advance and expressed in an addendum. If the owner's review and verification of the SSI's qualifications finds that any of the required criteria is not met the SSI may be disqualified from performing the work.

B. The work detailed in Division 28 must be completed by a single Security System Integrator (SSI) firm possessing in-house experience and skills through regularly employed engineers and technical staff so that all equipment may be properly integrated, assembled, tested and installed to provide a complete and properly working Security Control System. The work includes integration of existing security electronics sub-systems and components into the new control system, which requires substantial experience specific to correctional facility security electronics systems. Experience criteria:
   1. Key SSI personnel shall have a minimum of five (5) years of verifiable experience as a licensed contractor integrating, installing, and servicing integrated security systems of the type and magnitude of this project work, with no less than three (3) relevant projects completed in the last five (5) years.
   2. To be considered relevant, the experience shall be experience accomplished while having direct responsibility (and not reliant upon significant subcontracting other than electrical work), which was accomplished for correctional/detention facilities, involving at least fully integrated door/gate control systems with intercom and CCTV, and having a project contract value of $500,000 each, or greater.
   3. Experience based from a merged firm will only be counted if the same principal(s) of the firm having the experience are fully involved in the day-to-day operations of the current firm.

C. SSI support of installed integrated security systems is critical to the owner's mission. The SSI (firm) shall have facilities with technical staff having capabilities to fully support systems of the type and magnitude of this project which are located within a travel distance where emergency onsite support can be provided within a reasonable timeframe. The SSI shall have demonstrated provision of responsive system support after installation and completion of the warranty period at correctional/detention facilities. Firm experience criteria:
   1. The SSI (firm) shall have its own staffed service shop located such that qualified service personnel capable of troubleshooting and correcting hardware or software problems could be onsite within eight (8) hours of dispatch. For purposes of evaluation (only) this time limit shall be calculated as follows:
      a. If driving, the total drive time at legal speeds with normal traffic conditions, plus no less than 30-minutes if an international border crossing is required,
      b. If flying, add together the drive time from the service shop to the departure airport, 1-1/2 hours in the departure terminal, actual scheduled flight time including any connections (not adjusted for any time zone changes), 1/2-hour in the destination terminal, plus drive time with normal traffic conditions from the arrival airport to the site.
   2. The SSI (firm) shall have provided technical support on the site at not less than three (3) correctional/detention facilities on a purchase order/work order or maintenance contract basis, for integrated security systems which included a networked touchscreen interface PLC control system.

D. Key SSI personnel shall have performed their assigned duties successfully on projects of similar complexity and scale as this project, including projects while employed by the SSI. Criteria:
   1. SSI's proposed project manager (in-office), lead programmer, and field installation supervisor shall each have at least five (5) years of verifiable experience in those roles on completed correctional/detention projects of like magnitude and complexity.
   2. Each shall have at least two (2) fully completed projects of like magnitude and complexity while employed by any SSI. Projects which are incomplete will not be considered as meeting this criteria.

E. Security system software (PLC and HMI) programmers shall be regular employees of the SSI and shall have extensive experience in development of programming for correctional/detention facilities. The project schedule, and particularly the rigorous cutover requirements, requires that the SSI have available to the project no fewer than two (2) qualified programmers. Criteria:
   1. SSI shall have no fewer than two (2) PLC programmers who are regular employees of the SSI and who each have at least five (5) years of verifiable experience in programming Modicon PLC's using the same software specified for this project.
   2. SSI shall have no fewer than two (2) HMI programmers who are regular employees of the SSI and who each have at least three (3) years of verifiable experience in programming correctional/detention facilities touchscreen HMI's using the same software utilized for this project.
   3. The same individuals may be named in both categories.

F. Security system cutover within the time limitations specified will require the SSI to have sufficient qualified technical staffing, including engineers and technicians. The SSI shall demonstrate by documentation outlined below that it has resources available. Criteria:
   1. Capable of fielding a team consisting of two (2) or more persons, each having a minimum of two (2) years of experience in the implementation of security systems.
   2. Each team shall have one member who has a minimum of two (2) years' experience implementing networked Modicon PLC's.
   3. Individuals named may be the same as identified in paragraphs D and E above.

G. Verification of Firm and Individual Qualifications: The SSI shall, if requested, submit sufficient information to demonstrate that they meet each of the criteria set forth above.
   1. For each firm experience reference project submitted in response to the above criteria provide the following information:
      a. Name of the project
      b. Location
      c. Date of completion
      d. Owner
      e. Owner's representative contact, with phone number (must be familiar with SSI's work).
      f. Description and dollar value of each installed system.
      g. Name and specific responsibility for each key low voltage systems employee involved with the project.
   2. For service support capability and experience per paragraph C above provide detailed information regarding the service shop capabilities, including staffing and facilities. Provide calculation for anticipated response time to the project site from that service location. Provide project reference information for facilities where the SSI has provided significant onsite technical support.

3. For personnel experience provide the resume' for each of the SSI's key personnel who will be assigned to the roles described in paragraphs D and E above for this project. If these names are not the same as the names identified with the SSI firm's experience reference projects, as required above, submit additional experience projects to demonstrate the experience of those personnel.
4. Demonstrate and document to the extent necessary that sufficient qualified personnel meeting the criteria set forth above are available to accomplish the work of this project by submission of each staff member's resume' which shall have training and experience delineated.
5. If the SSI is not the prime bidder, and if requested by the owner, provide a letter from a bonding or surety company licensed to do business in the State of Washington attesting that the SSI would be granted, if required, a 100% Performance Bond to ensure completion of all of the security related work described in Division 28.
6. Provide a signed statement indicating that the SSI has the ability to provide the warranty service required elsewhere in this Section by factory trained and qualified service technicians, and that the capability will be maintained for the duration of the warranty period.
7. All of the verification of qualifications information described above shall be submitted to the Owner, if requested, and as stated in 'Division 00 Responsibility Criteria'.

## 1.04 SUBMITTALS – GENERAL REQUIREMENTS

A. Many individual Division 28 sections contain criteria for submittal requirements for that section. Comply with all individual section requirements.

B. Shop drawings shall be prepared in AutoCAD Version 2019 or newer. Provide electronic media copies of shop drawings in native AutoCAD and .pdf format.

C. Submittals shall include manufacturer's cut sheets with all data for each item in the security system. Include only information on exact equipment installed, not the complete 'line' of manufacturer. Identify the specific proposed equipment with a rubber stamp arrow or similar method. The engineer will not make selections for the contractor. Non-specific submittals will be returned for re-submittal. Indicate, utilizing arrows or clouding, the submitted product on cutsheets featuring multiple products. Failure to indicate submitted product will result in the submittal being returned for resubmission.

D. Submittals shall be assembled in a single package and shall be accompanied by a transmittal letter indicating the project name, Security System Integrator's name, date, and list of submittals included.

E. Assemble equipment submittal data in electronic PDF format. Provide cover sheet with name of project, job number and heading reading 'SECURITY SYSTEM SUBMITTAL DATA'. Include the low voltage contractor's name, address, and telephone number and the date of submittal completion, including any revision numbers and their dates.

F. Group information in sets subdivided by specification section, each section containing one copy of data for each item. Equipment submittals shall be in the same order as listed in the specifications.

G. Diagrams for systems to be complete drawings for specific systems installed include:
   1. Equipment location relative to other components. Rack and cabinet elevations, mounting details, floor plan drawings, and enlarged communication and electrical room layouts.
   2. Interconnection wiring diagrams with respect to inputs, outputs, power connections, terminal numbers, type of conductors and wiring techniques. Also provide block diagrams, wire lists and system schematics.

3. Block diagrams showing each system component layout and its electronic relationship with other components of this section and all related sections.
4. To scale mechanical drawings showing physical layouts and mounting details of each rack mounted components and custom control panel. Include front and back views.
5. Wire numbering associated with each termination point. This information shall be on the drawing at the terminal point and in a schedule format.

H. System input and output points shall have wire numbers identified with address numbers.

I. Floor plans to be modified contract drawings.

J. Submit wiring details indicating:
1. Wire type, gauge, insulation type, shielding, etc. identify as to each wires purpose (i.e. call-in, door position, etc.) and signal type (i.e. RS-232, RS-485, etc).
2. Wiring diagrams depicting exact interconnections of all devices.

K. Detailed wiring riser diagrams.

L. Provide block diagrams and shop drawings showing the details of all security equipment and proposed layouts of all control facilities. All such diagrams and drawings shall be submitted for approval prior to commencing fabrication and installation.

M. Point-to-point wiring diagrams showing all the field wire terminations, wire numbers, terminal points and terminal ID shall be provided for all new wiring.

N. PLC enclosure and rack layouts will be provided showing the quantity of each type of cable, use, and field wiring connections. Equipment cabinet layouts showing all components and their spatial relationship shall be provided.

O. A dimensioned drawing showing the location and dimensions of all the new security equipment provided under the contract, PLC equipment, racks, terminal cabinets, power supplies, computers, etc. in the existing security electronics rooms shall be provided.

P. Submittals received in other than the form described, may be returned without review for re-submittal by the Security System Integrator. Delay of project completion and/or assessment of liquidated damages, if applicable, due to re-submittal as mentioned above shall be the sole responsibility of the Security System Integrator.

## 1.05 OPERATIONS AND MAINTENANCE MANUALS (O&M MANUALS)

A. Prior to the completion of the contract, the owner’s maintenance instructional period, and final acceptance of the contract, the Contractor shall prepare Operations and Maintenance Manuals describing the maintenance and testing requirements and the components of all security systems and equipment provided under this Division. The O&M shall be submitted to the architect/engineer for approval as part of the substantial completion process. The accepted O&M’s shall be presented to and reviewed in detail with the Owner at the time of the Owner maintenance training and demonstration.

B. Manual shall be submitted as a single merged PDF file. Upon Owner request, the contractor shall provide a hard copy, 8-1/2”x11” in a three-ring binder with cover. Contractor may submit a request to submit O&M as hard copy for Owner approval. Indicate, utilizing arrows or clouding, the submitted product on cutsheets featuring multiple products. Failure to indicate utilized product will result in the O&M being returned for resubmission.

C. Systems and equipment described in the manual shall include but not necessarily be limited to all the equipment and systems provided under this contract. Group information contained in manuals into sets, subdivided by system, containing one (1) copy of data for each item.

D. Information contained in the manual shall consist of catalog data, parts list, description of operation, maintenance information, shop drawings, wiring and diagrams. Catalog data in the manuals shall be neat, clean copies. An index shall be provided, which lists all contents in an orderly manner. Bookmarks shall organize all components into logical categories. Provide a cover sheet with 'O&M Manuals for [Project Name], [Date], [Volume No. of No.]. Indicate the vendor or distributor who supplied each system or material. Include telephone number and address for each.

E. Provide the manufacturer's installation, programming and maintenance instructions for all material furnished under Division 28. Provide individual factory issued manuals containing all technical information on each device installed. Advertising brochures, catalog cut sheets, or operational instructions provided in lieu of the required technical manuals is not acceptable.

F. Provide one complete set of project RFI's and the associated responses.

G. Provide one complete set of all accepted Change Orders with any attachments.

H. Provide one complete set of bid Addenda.

I. Provide copies of the inspection sign-off sheets by Labor and Industries or the AHJ.

J. Provide all system test documentation as required by each related section.

**1.06 RECORD DRAWINGS**

A. Prior to final acceptance of the project the Contractor shall provide the following:
   1. Record Drawings: Corrections and changes made during the construction shall be neatly and legibly recorded on a set of prints and specifications kept readily available at the project site. All changes to the Bid Documents shall be recorded by the Contractor at the time they occur.
   2. The information to be documented shall include, but is not limited to, the following:
      a. Attach copies of all Addenda, clarification and revision drawings to their appropriate sheets.
      b. Indicate actual routing of systems conduits.
      c. Indicate any other information deemed to be beneficial to the Owner for maintenance or future maintenance or alteration purposes.
      d. Stamp, print or otherwise mark 'Record Set' on each sheet of the drawings. Mark the specification cover sheet with 'Record Set'.
      e. Indicate the date of Substantial Completion and the name and address of the Contractor's company on the cover sheet of the specifications and drawings.
      f. At Substantial Completion: Provide one set of Record Documents to the Architect for review and comment. Incomplete or unintelligible documents will be returned to the Contractor if deemed by the Architect not to accurately reflect the as-built conditions. Upon acceptance of the Record Document markups, the Engineer will provide copies of the AutoCAD files to the Contractor for final drafting. It shall be the Contractor's responsibility to transpose the Record Drawing information into the AutoCAD files and provide both the markups and a clean set of corrected plots (prints) for final review.

g. The changes or revisions to the specifications and schedules shall be made by hand to the record copy by the Contractor. Addendum items or other written revisions shall be taped over the appropriate section or referenced to an Appendix, added by the Contractor. Changes to the schedules shall be made by using whiteout to cover the original entry and neatly lettering in the new entry or by taping over with the new schedules.

h. After acceptance of the corrected documents the Contractor shall provide the following:
   1) One (1) set of prints, or quantity of prints specified in Division 01, whichever is greater,
   2) Three (3) sets of updated bound AutoCAD files and .pdf plots in electronic format.

i. The Contractor shall deliver the record documents through proper channels, obtain a signature receipt from the Owner and send copies to the Architect and Engineer.

## PART 2 PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment used on this project, unless specifically noted otherwise, shall be delivered to the contractor's shop or the site new, in original unbroken packages, and shall be of the best quality of their respective kinds. Re-manufactured or re-furbished products are not acceptable. All products shall be obtained from supply sources which are authorized dealers or vendors for the products, and the manufacturer's warranty shall be to the benefit of the owner if it extends beyond the contractor's warranty period.

B. All materials and equipment shall conform to the latest Standard Specifications of the American Society for Testing Materials, National Electrical Manufacturer's Association, National Board of Fire Underwriters, Institute of Electronic and Electrical Engineers, Electronic Industry Association, Federal Communications Commission, or other appropriate and recognized agency. Materials and equipment shall bear the stamp indicating listing by Underwriter's Laboratories, Inc. (UL). All materials shall be utilized in conjunction with their UL listing requirements.

### 2.02 SUBSTITUTIONS

A. Reference to Section 01 61 00 for substitution procedures.

### 2.03 OPERATING RANGE

A. All equipment items shall be selected and installed to provide fully normal operation in the anticipated ambient temperature range of 55 to 100 degrees F. Equipment located outdoors shall be weatherproof and shall operate over an ambient temperature range of at least -30 to +120 degrees F.

### 2.04 POWER SUPPLIES

A. 24 VDC Power Supplies:
   1. Output is to be regulated to within plus or minus 1.5 percent. Output to be auto reset on overload.
   2. Size as required for each location with a capacity of 150 percent of the intended maximum load.
   3. Class 2 power supplies shall be power limited to 100 watts with over-voltage and short circuit protection.
   4. Acceptable Products: IDEC, SOLA-HD or equal.

B. 24 VAC Power Supplies:
   1. Size as required for each location with a capacity of 150 percent of the intended maximum load.
   2. Class 2 power supplies shall be power limited to 100 watts with over-voltage and short circuit protection.

**2.05 OUTPUT AND INPUT FUSING**

A. Provide new terminal strips with integral fusing and blown fuse indicators.

B. All new inputs and outputs of field wiring shall be protected such that a short in the field wiring only affects the single device at the location of the short. All PLC digital inputs and outputs shall be protected.

C. Acceptable Manufacturers: Phoenix Contact or equal.

**2.06 SECURITY SCREWS**

A. Provide security screws of type approved by the Owner. Assume pin-Torx for purposes of bid proposal.

B. Security screws shall be used to fasten all security devices (i.e. intercoms, cover plates, intercom speakers, call buttons, cameras, junction boxes, etc.) in all correctional areas.

**2.07 BUILDING ENTRANCE PROTECTORS**

A. Provide building entrance protectors (BEP) on any new copper communication cable that exits the building envelope. Provide protectors on each end of the cable. Protectors for any copper telecommunications cabling falling within 22-26 AWG shall be products specified in Division 27.

**2.08 PANEL SURGE PROTECTION**

A. Provide each 20 amp 120V circuit providing power to security electronics equipment with a 120V surge protector. Surge protector shall be equal to Ditek DTK-120HW or approved equal.

**2.09 PUSH BUTTON DOOR RELEASE**

A. Provide Essex Electronics PEB Series pushbutton for door release buttons, Model PEBSSCB–US or approved equal. Provide with custom factory black laser engraving with the door number for identification. Flush mount on a single gang backbox. Connect to Access Control System such that upon pressing the button, the respective door unlocks for 20 seconds. When the button is illuminated Red, the door shall be locked, when illuminated green, the door shall be unlocked.

**2.10 WALL DISPLAY BACK BOX**

A. Display wall box shall be FSR Model PWB-100 or approved equal.

**2.11 INDICATOR LIGHT**

A. Indicator light shall be Federal Signal model SLM-1400, Amber color, with SLMBS-012-024GY base, or approved equal.

**2.12 POE SWITCHES**

A. 48 port PoE switches shall be Cisco 9200 Series or approved equal.

## PART 3 EXECUTION

### 3.01 GROUNDING

A. All equipment racks in a particular system shall be connected to the main building ground at only one point in each building. All other grounds, such as chassis, shielded audio pairs, coax, bulkhead connectors, etc., shall be insulated from duct work, plumbing, or conduits which in turn may cause accidental contact to the main station electrical ground at other points than that intended.

B. The Security System Integrator shall ensure that all ground connections are in accordance with applicable codes. Provide separate ground leads for equipment in control rooms and communication room. Isolation transformers shall be provided as required to prevent ground loops from one power source to another.

C. Provide a green #12 grounding conductor in conduit to every new door frame with 120 volts or greater lock or motor operator. Provide grounding per NEC requirements.

D. Grounding shall meet requirements of Section 26 05 26.

### 3.02 CABLING AND CONDUIT

A. All wiring and cabling outside of the equipment enclosures shall be installed in metallic raceways or cable trays.

B. This contractor shall coordinate, install, connect, and test, in addition to providing all equipment and materials for the systems herein specified. All wiring shall be neatly tied or laced in cabinets and terminated on terminal strips provided for the purpose. Each conductor shall be identified by an approved marking system at each terminal strip.

### 3.03 SOURCE QUALITY CONTROL

A. Shop QC Inspections:
   1. Have trained, qualified, quality assurance inspector regularly inspect shop assemblies. Inspect for quality of workmanship, neatness, part and wiring identification, conformance to codes and standards, and compliance with system specifications and shop drawings.
   2. The Engineer may verify the inspections or inspect any item. The Engineer reserves the right to reject materials and workmanship found unacceptable during inspections.
   3. The Engineer shall always have the right to inspect or otherwise evaluate the project work performed or being performed and shall have access to the premises in which the work is being performed.

B. In-Shop QC Testing and Burn-In, and In-Shop Testing/Demonstration (Bench Test):
   1. To the greatest extent possible all active electronics equipment for each system shall be fully assembled and tested at the installer’s shop. Where necessary to fully demonstrate functionality and proper integration the contractor shall obtain representative examples of equipment existing at the site. All costs incurred in meeting this requirement are to be included in the bid.
   2. All equipment shall be powered up and burned in for a two-week period prior to Testing and Demonstration.
   3. Notify the Architect/Engineer of Bench Test readiness a minimum of 15 working days prior to in-shop testing so that the Owner and others may be scheduled to witness testing.

4. In-shop Testing and Demonstration shall be a major milestone event that shall commence only after all shop assembly, system integration, and software development is complete and the contractor has performed his own QC testing. After fabrication, assembly and programming of the security electronics systems, perform in-shop testing and provide a detailed Demonstration of the fully integrated security electronics system, with all components functioning as a single, integrated system. Testing and demonstration shall be able to be completed with no significant errors or failures.
5. Conduct system tests in strict accordance with an Engineer-approved test procedure. Provide means for testing to demonstrate proper function of each type of field device in the system, and that all components of the system function properly under simulated "load" of random events. Demonstrate full compliance with the required operating modes and sequences of operation. Record test results on a report which shall include a list of all personnel witnessing the tests, test methods used, and a record of each specific test made, and the result.
6. If test results are not in compliance with requirements, make necessary changes, corrections, repairs or adjustments at no additional cost and arrange for another factory test. This process shall continue until the systems are acceptable to the Architect.
7. Engineer's approval of the integrated In-shop Test and Demonstration shall be obtained before the shipment of any system components to the site for installation.

## 3.04 FIELD TESTING AND PRE-INSTALLATION

A. Field test continuity of all field wiring and verify all aspects of remote device operation. Notify the Engineer of any discrepancies.

B. Ensure that all necessary components and facilities are available and that the work elements and sequences necessary for completion are clearly understood by the installation technicians.

## 3.05 SEQUENCE OF INSTALLATION

A. It is the responsibility of the Contractor to closely coordinate and pre-plan his work to minimize the system downtime. Advance coordination with the Owner will be required, and any system interruptions shall only occur with the specific advance approval of the Owner – minimum 10-day notice.

## 3.06 ENGINEER'S INSPECTION AND PUNCHLIST

A. Contractor shall notify the Engineer in advance of his readiness for the final punchlist at each project area.

B. The Contractor shall provide two technicians to assist the Engineer when performing the punchlist. All functions of the security system will be systematically checked in the presence of the Engineer. The Contractor shall provide radios for communication and any test equipment requested by the Engineer.

C. After installation is complete and the entire system has been tested for proper operation and for satisfactory conformation with the requirements of the contract documents, Substantial Completion will have been attained.

D. The Contractor shall complete all items on the punchlist and any other unfinished work. One additional Engineer's trip will be allowed to verify that all items have been completed, with the date to be mutually agreed upon by the Contractor and Engineer. The Contractor shall bear the full cost for any additional trips that are required due to incomplete work or non-functional systems. The additional trips will be billed at the Engineer's customary hourly rate.

## 3.07 OPERATOR TRAINING

A. At the time the new system is put online the Contractor shall provide Operator Training to the Owner's personnel. This training shall be provided one time to each working shift (3 sessions) and shall cover all aspects of operation and report generation.

B. One session shall be video/audio recorded, to be provided to the Owner in advance of O&M submission (for further internal training use), and again with the O&M closeout materials. Format for deliverable shall be USB Flash Drive or DVD. For each submission provide four (4) copies with viewing software if not standard Windows Media Player® compatible.

## 3.08 MAINTENANCE TRAINING

A. Subsequent to approval and delivery of Operation and Maintenance Manuals, at a time convenient to and selected by the Owner, the Security System Integrator shall provide instruction by Contractor's and Manufacturer's personnel familiar with the design and operational functions of the Systems to the Owner's operating and maintenance personnel. This training shall cover all aspects of system configuration, operation, reporting, diagnostics, maintenance requirements, troubleshooting, and software customization.

B. The training sessions shall be held at the facility and shall be video/audio recorded, to be provided to the Owner with the O&M closeout materials. Format for deliverable shall be USB Flash Drive or DVD. Provide two (2) copies with viewing software if not standard Windows Media Player® compatible.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. This section is a Division 28 Basic Electrical Materials and Methods section and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplemental Conditions, Division 01 Specification sections and all Division 28 sections, apply to work of this section.

## PART 2 GENERAL PROVISIONS

### 2.01 CONTRACT DRAWINGS

A. The contract drawings indicate the extent, the general character, and the approximate location and arrangement of equipment, conduit, ground connections and wiring. Contractor shall study building plans and details and shall cooperate with all other trades to prevent conflict and interference as to space requirements so that outlets and equipment will be properly located and readily accessible. The layout does not necessarily show the total number of raceways or boxes required, nor are the location of indicated runs intended to show the actual routing of the raceways. The Contractor shall provide all raceways, boxes, conductors, connections, supports, and all other materials required for the electrical systems shown or noted in the contract documents to be complete and fully operational upon completion of the project.

B. Division 28 equipment shall be properly supported to comply with applicable codes and good work practice. Be responsible for installation of a complete electrical installation in accordance with the true intent of the drawings and specifications.

C. The scale of drawings cannot show all necessary transitions, offsets, changes in direction, etc. The drawings do not necessarily show every pull or junction box required. Provide all boxes necessary to install work to conform to the structure, preserve head room and keep openings and passageways clear.

D. Diagrams, details, risers and One-Line Diagrams are schematic only, not to scale, and do not necessarily show physical arrangement of equipment. Diagrams and plans are complementary and what is shown on either is same as if shown on both.

E. The specifications and drawings are complementary and what is required in either is as binding as if indicated on both. Where a conflict exists between what is shown on the drawings and what is called for in the specifications, the more stringent of the two shall govern.

F. The Contractor will not receive extra compensation for cutting, patching, wiring and finishing required for relocation of work installed due to interference between the various work that could have been avoided, had proper coordination been applied. The Contractor is advised to contact the Architect or Engineer to clarify any situation that does not appear to conform with standard practice.

G. The Contractor shall make provisions for the delivery and safe storage of materials and make arrangements with the other work of other Divisions for entry into buildings of equipment too large to pass through finished openings. Be responsible for materials and equipment furnished to him by others for installation into the project. Material damaged during construction shall be replaced or repaired to the Owner's satisfaction.

### 2.02 REFERENCE SYMBOLS & DEFINITIONS

A. ADA Americans With Disabilities Act

| | | |
|---|---|---|
| B. | Ampacity | Capacity expressed in amperes |
| C. | ASTM | American Society for Testing & Materials |
| D. | EMT | Electrical Metallic Tubing |
| E. | Galv | Galvanized |
| F. | Mfg. | Manufacturer |
| G. | NEC | National Electrical Code |
| H. | NBFU | National Board of Fire Underwriters Pub. 70 (latest edition) |
| I. | UBC | Uniform Building Code |
| J. | Furnish | Supply |
| K. | Install | Install or apply |
| L. | Provide | Furnish and install |
| M. | UL | Underwriters Laboratories, Inc. |
| N. | IPCEA | Insulated Power Cable Engineers Association |
| O. | NEMA | National Electrical Manufacturers Association |
| P. | IEEE | Institute of Electrical & Electronic Engineers |
| Q. | NFPA | National Fire Protection Association |
| R. | Indicated | Indicated on drawings |
| S. | Concealed | Hidden from sight as in trench, chases, slabs, furred spaces or hung ceilings |
| T. | Exposed | 'Not concealed' as defined above |
| U. | Contractor | Shall mean the General Contractor who signs the contract with the Owner |

**2.03 CODES & FEES**

A. The installation of this work shall comply in every way with the requirements of the laws, ordinances and rules of the State of Washington, the National Electrical Code, and WISHA.

B. If any conflict occurs between these rules and this specification, the rules shall govern. Nothing in these drawings and specifications shall be construed to permit work not conforming with governing codes. This shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of hereinbefore mentioned rules and not contrary to same.

## PART 3 EXECUTION

### 3.01 WORK INCLUDED

A. It is the intention of this Division of the specifications and the accompanying drawings to describe and provide for furnishing installing, testing and placing in satisfactory and successful operation, all equipment, materials, devices and necessary appurtenances to provide a complete security control system. The work shall include all materials, appliances and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working installation including support and accessibility of all security and electrical systems shown on the plans or described herein. Certain equipment and devices furnished and installed under other contracts shall be connected under this contract.

B. All work and materials shall be subject to inspections at any and all times by representatives of the Owner and/or Architect.

C. The Contractor shall circuit all devices and equipment to the rack as indicated or specified. Any deviation from the drawings shall be approved by the Engineer, documented by the Contractor and approved by the Labor and Industries Inspector.

### 3.02 CUTTING, PATCHING, EXCAVATION AND BACKFILL

A. Workmanship shall be of the best quality and none but competent mechanics shall be employed and shall be under the supervision of a competent foreman. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.

B. No cutting of structural members will be allowed without the Architect's written permission.

C. All patching provided by the Contractor shall be done by mechanics skilled in their trade and shall be complete in every detail and shall comply with Division 01 and appropriate sections of the specification for material, finish, etc. All patching shall be reviewed by the Architect for acceptability.

### 3.03 CLEANUP

A. Continually remove debris, cuttings, crates, cartons, etc. created by his work from the inside to the secure perimeter on a daily basis. Such shall be done at sufficient frequency to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation by the Owner, carefully clean cabinets, panels, boxes, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.

### 3.04 PAINTING

A. Touch up or repair of factory finishes that are scratched or marred in shipment or installation shall be the responsibility of this Division. Repairs shall be made to the satisfaction of the Owner and/or Architect.

### 3.05 EXAMINATION OF SITE

A. Before submitting bids, all bidders on Division 28 work shall visit the site to satisfy themselves as to the nature and scope of all work to be done. The submission of a bid will be taken as evidence that such an examination has been made and difficulties, if any, noted. Later claims for labor, work, materials and equipment required for any difficulties encountered which could have been foreseen, will not be recognized and all such difficulties shall be properly remedied at no additional expense to the Owner.

## 3.06 SAFETY CONDITIONS

A. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Architect to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's performance measures, in, on, or near the construction site.

B. Furnish, erect and maintain all barricades, guard structures, warning signs, detour signs and lights as may be required to protect and safeguard from injury or damage.

C. Provide bracing, scaffolding, guard rails and protective devices necessary to protect workmen and personnel from personal injury while on the jobsite.

D. Contractor shall be liable for all damage and injury occurring to the Owner's property on or in the adjacent areas of the work, or which shall occur to any person or property whatsoever by reason of the negligence of the Contractor or any of his employees, or sub- Contractors, or of any breach or violation of the provisions of this agreement, or of any of his duties or obligations under the contract.

## 3.07 PROJECT CLOSEOUT

A. At the time of monthly and final inspections, the project foreman shall accompany the inspection party, and remove plates, covers, ceiling tiles and other access panels and unlock doors for the inspecting Engineer, to allow complete inspection of the entire security system in an efficient manner.

B. The Contractor shall provide all ladders and tools required by the inspecting Engineer. The Contractor shall open any panel, box, control station, racks, etc. as requested for the Architect/Engineer’s inspection.

C. Guarantee: This Contractor shall be responsible for all work put in under this specification. Make good, repair or replace, as may be necessary, any defective work, materials or parts which may show itself within one year after date of owner occupancy and one year for labor, if in the opinion of the Architect, said defect is due to imperfection in materials, design or workmanship. Comply also with requirements of other divisions of specifications.

D. The Contractor shall leave the job in complete order ready for use. All refuse shall be removed, all fixtures, devices and equipment shall be tight, fully equipped and completely cleaned. Operation personnel shall be thoroughly indoctrinated in the operation of electrical and systems equipment. All remaining items not used in the project, but billed for shall be delivered in like new condition to the Owner's on-site storage facility.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. This section is a Division 28 Basic Materials and Methods section and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplemental Conditions and Division 01 Specification sections apply to work of this section.

### 1.02 SCOPE OF WORK

A. The work under this section shall include providing all labor, equipment and materials of every kind necessary to complete the demolition and removal of existing security system components as shown on the drawings and described herein.

B. Demolition is to coincide with the phased construction cutover. The facility is to be occupied and remain in operation throughout the project.

C. Downtime shall be held to a minimum, outages shall be scheduled at a time acceptable to and approved by the Owner. This may require work involving system outages to be done at night, early morning or other non-standard hours.

### 1.03 DESCRIPTION OF WORK

A. Demolish existing security equipment in the least intrusive manner possible to mitigate interference with the operation of the facility. A schedule of work, period of outage and backup plans shall be approved by the Owner prior to taking down any security systems. Thorough coordination with the Owner's representative must occur at least two weeks prior to shutting down any security systems.

B. Contractor shall transport and legally dispose of offsite, all materials resulting from demolition not being salvaged. Disposal procedures for hazardous materials shall be in accordance with applicable laws and regulations.

## PART 2 SALVAGE

### 2.01 SALVAGE

A. The Owner shall have first salvage rights. Materials shall be disconnected and removed in a manner that will not cause damage or impair its ability to be re-deployed. The Contractor shall deliver to the Owner at a location as directed all items requested to be salvaged by the Owner.

B. Contractor Salvage: Items of salvageable value to Contractor which are not claimed by the Owner may be removed from the structure as work progresses. Contractor salvaged items must be transported from site as they are removed. Storage or sale of removed items on site will not be permitted.

## PART 3 EXECUTION

### 3.01 DEMOLITION AND REMOVALS

A. Conditions and Premises: The Owner assumes no responsibility for the actual condition of premises. Owner will maintain general conditions existing at time of inspection for bidding purposes.

B. Protection: Ensure safe passage of persons around areas of work. Conduct operations to prevent injury to adjacent buildings, structures, other facilities and persons.

C. Damages: Promptly repair damages caused to adjacent facilities by demolition operations at no cost to the Owner.

D. Patch and repair all existing floor, wall and roof penetrations not being re-used. Comply with Division 01 General Requirements.

E. Equipment demolition shall include removal of all exposed connecting conduit, surface raceways, outlet boxes, etc., either to a point below floor, behind wall surface, etc.

F. Where the phrase ‘extend wiring’ is used it requires the removal of existing wiring, the extension of the conduit run and the pulling in of new wiring.

G. The cost of patching and repairing all walls, ceilings and floors, which are to remain and are damaged, cut, drilled or altered for the installation or removal of security work, is the responsibility of Division 28.

H. All abandoned wiring and cables are to be removed.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Provide an electronic access control system and other relevant components and accessories required to provide a complete operating system as specified herein.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 sections and Section 260500 apply to Work in this section.

### 1.02 RELATED SECTIONS

A. Related Sections
   1. 260500 – General Electrical Provisions
   2. 260510 – Basic Electrical Materials and Methods
   3. 260533 – Raceway Systems
   4. 260534 – Outlet Boxes
   5. 271100 – Telecommunications System
   6. 281600 – Intrusion Detection System
   7. 282300– IP Security Video System

### 1.03 QUALITY ASSURANCE

A. The system and its components shall be Underwriters Laboratories, Inc., listed under the appropriate UL testing standard as listed herein for security access control applications.

B. Codes and Standards:
   1. American National Standards Institute (ANSI):
      a. ANSI C63.4 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
   2. Federal Communications Commission (FCC):
      a. Title 47 CFR – Part 15; Class B – Radiated and Conducted Emissions.
      b. Title 47 CFR – Part 68; rules governing the connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN).
   3. Underwriters Laboratories, Inc. (UL):
      a. UL 50 – Enclosures for Electrical Equipment.
      b. UL 294 – Access Control System Units.
      c. UL 60950-1 – Information Technology Equipment - Safety.
   4. National Fire Protection Agency (NFPA):
      a. NFPA 101 Life Safety Code.
   5. Provide all wiring in accordance with Article 725 of the National Electrical Code and local ordinances, and other sections of these specifications.

C. Qualifications:
   1. Contractor shall be a certified reseller/ dealer, pre-qualified by the manufacturer for the purpose of offering the services as specified herein, at the time of bid.
   2. Contractors bidding security work shall have a minimum of five years of experience in the construction, testing, and servicing of systems of the type and magnitude specified herein.
   3. The contractor shall have completed at least five projects of equal or larger in size to this project within the past five years.

4. Contractor shall have direct access to the tools and test equipment required to complete the work as defined herein.
5. The contractor shall employ certified technicians skilled in the maintenance of the access control system and shall be located within 100 miles of the project site.

## 1.04 SUBMITTALS

A. Provide submittals in accordance with Division 01 and Section 260500.

B. Product Data:
   1. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.
   2. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
   3. Submit Product Data information sheets for coordination with item and model number.
   4. Where more than one product is shown on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
   5. Submit resumes and certifications of technicians and project manager who will support this project. Certifications shall include:
      a. Manufacturer’s certification to provide warranty
      b. Approved manufacturer classes satisfactorily completed

C. Acceptance Test Plan:
   1. An acceptance test plan form shall be prepared/ provided by the contractor.
   2. This form shall include separate sections for each device and 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.

D. Shop Drawings:
   1. Drawings shall provide details of proposed system and the equipment and work to be provided. Drawings shall include devices located on the floor plan, point-to-point drawings of systems and wiring diagrams of individual devices including voltage drop calculations and other calculations as required.
   2. Connections to other equipment/ systems not specified herein.

E. Record Drawings:
   1. Keep complete set of security drawings in job-site office to show actual installation of cabling and equipment during construction.
   2. Use of this set of drawings for recording as-built conditions.
   3. Indicate where material, equipment, and system component are installed differently from that shown on the Drawings.
   4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner’s Representative for review and acceptance.
   5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.
      a. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.
   6. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format, on flash drive.

F. Project Closeout:
   1. Submit closeout documentation to the Owner's Representative and Architect under provisions of Division 01, Section 260500 and this section.
   2. Provide all project closeout documentation including but not limited to; test acceptance documentation, Record Drawings, manufacturer warranty and Operation and Maintenance Manuals.

## 1.05 SYSTEM REQUIREMENTS

A. Type of System:
   1. The system shall be programmable locally and/or remotely.
   2. Wireless access control door hardware shall communicate over a secure 2.4 GHz frequency. Wireless door hardware is furnished under Division 08.
      a. Licensing, configuration and installation shall be provided under this specification.
   3. Access control system shall provide the following card access control operational objectives:
      a. Controlled entry, via access card readers, of only authorized personnel to secured areas based on cardholder information entered and stored in the system database.
      b. Access request response time from card presentation, data base verification, to electric lock unlock shall be no more than one second in normal operating mode on a fully loaded system.
      c. Access requests, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with the cardholder number, name, and access point/area where access was attempted or gained.
      d. Each card can be disabled at any time, manually or scheduled within the system.
      e. Each cardholder shall be granted with access authority to a specific or combination of security areas.
      f. System shall provide for the designation of certain calendar days to be holidays, with special access privileges and system activity to be specified for those days.
   4. The system shall provide the following relay output control and operational functions:
      a. Each security system output point (door lock, gate controller and other associated relay outputs) shall have a user-specified 16 character, minimum, test identifier. Each point shall be software programmable for activation and deactivation, and shall be capable of reporting short circuit trouble, open circuit trouble, ground fault trouble and circuit fault trouble.
      b. System shall allow activation and deactivation of output points manually by the operator, automatically by time zone, automatically by the activation of an alarm point, or where required by a card reader.
      c. System shall allow disabling the exterior auto operator button when door hardware is in a locked state.
      d. System shall allow control (enable/disable) over the elevator call/ cab buttons.
   5. System shall provide lockdown functions via push buttons as indicated on the Contract Documents.
      a. When the lockdown button is activated it shall override all scheduled openings and lock/close all electronic controlled doors/gates.

## 1.06 PRE-CONSTRUCTION MEETINGS

A. The subcontractor shall attend the pre-construction meeting as required by the Contractor or the Owner's Representative.

B. Provide a schedule, indicating installation tasks, time duration for each task and coordination items to be discussed 5 days prior to the meeting, to the Contractor and to the Owner's Representative.

### 1.07 MATERIAL PROVISIONS

A. Deliver materials to the Owner under provisions of this section.

B. Contractor shall be responsible to provide a material transmittal for all materials being provided to the Owner as described herein and that are not permanently installed. Transmittal shall be signed by the General Contractor and the Owner receiving the materials.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

A. Substitutions: The substitution of products shall not be considered under the terms and conditions of this Section.

B. Access Control System:
   1. Best WiQ Access Control System is existing and is being expanded under this project.

C. Licenses:
   1. Licensing shall be based upon the number of readers, wireless access control door hardware, and selected features. User license shall include one year of software updates from the date of shipment from the factory.
      a. Software Support Plan:
         1) Provide one additional year of support coverage to support the system as specified herein and as indicated on the Contract Drawings.

D. System Hardware:
   1. Access control panel shall be an UL 294-Listed enclosure. Equipment shall be provided as required to support all end devices specified herein and as shown on the Contract Drawings.
      a. Provide Gateway Portals (GP) as required to support the wireless devices in the project. The drawings indicate locations. Contractor shall add Portals as required such that all devices work as intended at no extra cost. Provide Antenna as required.
         1) Model WQX-PG-XX (where XX indicate antenna)
      b. Provide Wireless Access Controllers (WAC) as indicated for all doors indicated in the documents.
         1) Model WQX-WAC-C
         2) Provide 24 VDC Power from the PLC cabinet power supplies to the WAC. Provide 2 #14 conductors for 24 VDC Power.
         3) Provide 2 #18 conductors as an output from the PLC to the input on the WAC for door unlock.
         4) Provide WAC in an enclosure in accessible ceiling space.

### 2.02 POWER SUPPLIES AND BATTERIES

A. Power Supplies:
   1. Power supplies shall be UL 294-Listed for 12V DC and 24V DC applications. Power supplies shall include 4-hour battery backup with under voltage protection. During a power interruption, power supporting security devices shall be interrupted if battery voltage drops below security device manufacturer recommendations.
      a. Manufacturer Altronix, or approved equal

B. Batteries:
   1. Batteries and associated equipment shall be provided as required to support the system as specified herein.
      a. Door hardware power supply batteries.
         1) Manufacturer, Power Sonic, 12V 7Ah, Part No. PS-1270
      b. Access control panel power supply batteries.
         1) Manufacturer, Power Sonic, 12V 5Ah, Part No. PS-1250

## 2.03 ACCESS CONTROL DEVICES

A. Cards and credentials shall be provided by the Owner. Provide all programming required to integrate the existing credentials.

B. Credential Readers:
   1. Signo Readers:
      a. Contactless smart card reader shall comply with the ISO 13.56MHz-related standards and bidirectional communication in compliance with v2 of the SIA OSDP (Open Supervised Device Protocol) standard. Shall support 125 kHz proximity FSK (HID Proximity, AWID). PSK (Indala) and ASK (EM4102) 125 kHz technology.
      b. Contactless smart card reader shall follow the standards-based, device-independent Security Identity Object™ (SIO) portable credential methodology. The SIO shall be able to reside on any number of identity devices, including Seos, iCLASS SE, iCLASS SR, MIFARE Classic, and MIFARE DESFire EV1/EV2 credentials.
      c. Contactless smart card reader shall support, by default, Apple's Enhanced Contactless Polling (ECP) to support credentials in the Apple Wallet and Bluetooth Low Energy (BLE) and NFC card emulation mode. Reader shall be environmental rating of IP65.
         1) Manufacturer HID:
            a) Mullion reader, Part No. 20NKS-00-000000
            b) Mullion PIN pad reader, Part No. 20KNKS-00-000000
            c) Standard reader, Part No. 40NKS-00-000000
            d) Standard PIN pad reader, Part No. 40KNKS-00-000000

## 2.04 CONTROL BUTTONS AND RELAYS

A. Emergency Lockdown Button (Under Desk Mount):
   1. Emergency lockdown button shall be maintained, normally open DPDT contact.
      a. Manufacturers, or approved equal:
         1) Honeywell, Part No. 269R
         2) Potter, Part No. HUB-M

B. Emergency Lockdown Button (Wall Mount):
   1. Emergency lockdown button shall be red twist release mushroom style, blue shell white lettering reading "LOCKDOWN", maintained, normally open SPST contact with protective cover.
      a. Manufacturer STI, Part No. SS2421LD-EN

C. Door Release Button (Wall Mount):
   1. Door release button shall be green in color, momentary, normally open with Form "C" contacts.
   2. Custom button label shall read "PUSH TO OPEN" and faceplate label shall read "DOOR RELEASE".

a. Manufacturer STI, Part No. UB-1

D. Auto Operator Time Delay Module

1. Auto operator time delay module shall be designed to have programmable modes that include up to 3 door sequencing, airlock, lock-out relay, fire door in stairwells, and for control of automatic operators in restroom applications, with support of illuminated indicator of occupancy status.

a. Manufacturer Camden, Part No. CX-33

## 2.05 NOTIFICATION DEVICES

A. Sounder/ Strobe:

1. Sounder/ strobe shall be a durable indoor/outdoor self-contained device. Sounder shall consist of a single tone that delivers a warble sound output, 120dB output siren driver, and a dual action reed plunger for cover and rear protection. Strobe shall an adjustable flash rate of 20 – 10 times a minute. Housing shall be polycarbonate with a sturdy aluminum back plate to prevent warping and cracking. Sounder/ strobe shall operate at 748mA at 12VDC with a voltage range of 9.6 – 14.4 VDC.

a. Manufacturer Potter:

1) Sounder/ strobe amber lens, Part No. SSX-52SA

2) Sounder/ strobe blue lens, Part No. SSX-52SB

3) Sounder/ strobe clear lens, Part No. SSX-52SC

4) Sounder/ strobe red lens, Part No. SSX-52SR

B. Interior Chime/ Strobe

1. Chime strobe shall be a 60dB UL listed for wall installation. Chime strobe shall comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range. The strobe shall have field-selectable candela settings including 15, 30, 75, 95, 110, 135, and 185. Strobe light shall consist of a xenon flash tube and associated lens/ reflector system. Chime shall have two audibility options and an option to switch between a temporal three pattern and a non-temporal (continuous) pattern.

a. Manufacturer System Sensor:

1) Chime strobe, Part No. CHSWL

2) Lens, amber, Part No. LENS-A2

3) Lens, blue, Part No. LENS-B2

4) Lens, green, Part No. LENS-G2

C. Exterior Strobe:

1. Exterior rated strobe shall be LED UL listed, corrosion resistant Type NEMA 4X. The base shall be in the color black with 1/2-inch or 3/4-inch NPT for conduit mounting. Lens shall be made of shatter resistant polycarbonate. Strobe shall operate Steady-On/Flashing 65 fpm at 24VDC, 0.215A.

a. Manufacturer Edwards Signaling:

1) Red lens, Part No. 125XBRMR24DB

2) Amber lens, Part No. 125XBRMA24DB

3) White lens, Part No. 125XBRMW24DB

4) Blue lens, Part No. 125XBRMB24DB

5) Green lens, Part No. 125XBRMG24DB

6) Wire guard, Part No. 125GRD

D. Emergency/ Duress Strobe:
   1. Emergency/ duress strobes shall be a xenon light source with flash rate 60 fpm. Housing shall be polycarbonate vandal-resistant IP65 with safety locking mechanism. Beacon shall be fitted with a diffuser and operate on 12VDC, 0.06A, at 1 watt.
      a. Manufacturer Edwards Signaling:
         1) Red lens, Part No. 45-713111
         2) Amber lens, Part No. 45-713121
         3) Clear lens, Part No. 45-713131
         4) Blue lens, Part No. 45-713141
         5) Green lens, Part No. 45-713151
         6) IP67 upgrade kit, Part No. 45-710002

## 2.06 MONITORING DEVICES

A. Request-to-exit (REX):
   1. Doors with electronic door hardware shall contain an internal micro switch REX device, coordinate with Division 08.

B. OR
   1. Request-to-exit device shall be UL 1638 and UL 464. REX shall feature timers, door monitor with sounder alert, and adjustable coverage, the REX shall have Sequential Logic Input (SLI). REX shall operate at 12VDC with 8mA nominal standby current and 39 mA in alarm. Alarm output shall be by two Form C relay contacts each rated 1 A at 30VAC/VDC for resistive loads.
      a. Manufacturer Bosch, Part No. DS160

C. Magnetic Door Position Switches:
   1.
   2. Recessed
      a. Door contacts shall be UL listed 1-inch diameter magnetic door contact DPDT (double pole/ double throw) switch. Contact shall be self-locking for recessed mounting, closed loop, with 12-inch #22 AWG leads and 1-inch gap.
      b. Hardware, mounting brackets, adapters and plates shall be provided as required for magnetic contact switch installation.
         1) Manufacturer Nascom, Part No. N1178Cx/STDD, or approved equal
            a) x = denotes color, (W) white, (T) tan, (G) gray and (B) brown.
   3. Surface Mount
      a. Door contact shall be a hermetically sealed reed switch nominally 3"L x 1"H x 0.50"D with matching actuating magnet. Mounting holes shall be on 2-inch centers. Contact and magnets shall be in brushed anodized aluminum tube housing. Contact shall be sealed in our exclusive polyurethane potting compound. Right angle mounting bracket shall be included with contact.
         1) Manufacturer Interlogix, Part No. 2507AD-L
   4. Overhead Surface Mount
      a. Overhead door contacts shall be U.L. Listed heavy-duty SPDT (Single-pole-double-throw) surface mounted magnetic contacts with 3-inch minimum gap size.
         1) Manufacturer Nascom, or approved equal:
            a) Channel mount, Part No. N505AUTMC/STSD

5. Specialty Magnets:
    a. Where door contacts are required at metal store front doors with top channel provide channel magnet, clip legs to accommodate shallow channel. Magnet shall be housed in flexible plastic housing with legs at each corner.
        1) Manufacturer George Risk Industries, Part No. MC-180, or approved equal

## 2.07 ELECTRONIC LOCKING HARDWARE

A. Electronic locking hardware shall be provided by Division 08.

## 2.08 GATE PEDESTAL AND HOUSING

A. Pedestal/ Stanchion:
    1. Stanchion shall be heavy duty, made of 4.0-inch square x .12-inch tube steel with a black UV protectant polyester powder coat. Stanchion shall be 44.65-inch tall with a 13.0-inch reach. The faceplate and baseplate shall be 8-inch square universal mount.
        a. Manufacturer Pedestal CEO, Part No. HD-100

B. Housing:
    1. Housing shall be made of .5-inch polymer composite material and be 3.0-inch deep. The hood portion shall be made from .25-inch material and be 3.5-inch deep. Housing shall be UV rated with stainless steel hinge.
        a. Manufacturer Pedestal CEO, Part No. LANDO-KY-20x14-E-BLK

## 2.09 OPEN CABLING SUPPORTS

A. Accessories and mounting hardware shall be provided for securing supports to structure for a complete and working installation of open cabling supports. Supports shall comply with TIA requirements for structured cabling systems and pathway supports. Follow manufacturer's recommendations for quantity of cables supported.

B. Hook & Loop Fasteners:
    1. Hook and loop fastener rolls shall be offered in 15 and 75-foot lengths and be 0.5-inch in width. Shear strength; for plenum rated product shall be 29 PSI and non-plenum rated product shall be 23 PSI. Hook and loop fasteners installed in plenum air spaces shall be UL Listed (plenum) and be in the color maroon.
        a. Manufacturer Leviton or equal:
            1) Non-plenum 15' roll, Part No. 43115-15
            2) Non-plenum 75' roll, Part No. 43115-75
            3) Plenum 15' roll, Part No. 43115-15P
            4) Plenum 75' roll, Part No. 43115-75P

C. Circular Cable Retainer:
    1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
        a. Manufacturer Erico Caddy, Part No. CAT CR50

D. J-Hooks:
    1. J-hooks shall have a Galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
        a. Manufacturer Erico Caddy:
            1) 1-inch Dia., Part No. CAT16HP
            2) 1-5/16-inch Dia., Part No. CAT21HP

### 2.10 CABLING

A. Cabling shall be sized to provide minimum resistance and minimum voltage drop to the devices being supplied. Voltages delivered to all devices shall be within the tolerance specified by the device manufacturer.
   1. Cabling shall be a minimum 18 AWG solid copper conductors for power connectivity.
   2. Twisted pair cable shall be used to prevent EMI/RFI interference with the proper operation of the circuits.

B. Cable shall be NFPA 262, CMP (plenum) rated unless otherwise noted.
   1. Cables installed in underground applications shall be rated for wet environments.

C. Cables shall adhere to the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
   1. Wiring shall be appropriately color-coded with permanent wire markers.
   2. Cabling shall have stranded copper conductors.
      a. Card readers: 18 AWG-6C with overall shield.
      b. RS-485: 24 AWG one twisted pair with overall shield
      c. Door position switch: 22 AWG-2C
      d. Lockdown buttons, keyed switch: 18 AWG-4C
      e. Request to exit: 18 AWG-4C
      f. Electrified lock/ exit device: 16 AWG-6C
         1) Refer to manufacturer requirements.
      g. Electrified mag lock/ hold open: 16 AWG-2C
      h. Sounder/ strobes w/tamper switch: 18 AWG-4C

D. Coordinate additional cabling requirements, other than those listed herein, for devices within the access control system shop drawings.

### 2.11 TERMINAL BLOCKS

A. Terminal blocks shall be screw connection, two connections with 1 position, 24 – 12 AWG and mount on DIN rails.
   1. Manufacturer Schneider Electric, Altech or equal

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Provide all labor, tools, supplies, software, hardware, materials, and equipment required for the design, installation, configuration/ programming and testing of a complete and operational system.

B. Install all equipment in accordance with manufacturer's instructions, approved Shop Drawings and as indicated on the Contract Documents.

C. Cabling shall be installed in conduit at non accessible locations, cable tray or open cabling supports in accessible ceiling spaces.

D. Where subject to mechanical damage, wiring shall be enclosed in metallic conduit and/ or surface metallic raceway.

E. Cabling shall not be enclosed in conduit or raceways containing AC power.

F. All devices shall be securely mounted. Provide necessary backing in walls or ceilings.

G. Properly ground the system per NEC requirements to the building safety grounding system to prevent electrostatic charges and other transient electrical surges from damaging the control panel.

H. Door hardware power supplies, by others, shall be located near doors with electronic door hardware where there are accessible ceiling spaces.

I. Provide connections to lockdown button(s), where indicated on the Contract Documents. Lockdown button shall provide manual override to lock or unlock electronic controlled doors.

J. Auto operator motor (ADA button): provide relays and cabling for card reader operation with ADA operators. Coordinate requirements with the electrical and door hardware contractors.

K. Elevator landing control: provide terminal strips and cabling for card reader operation with call buttons/ elevator cab. Coordinate requirements with the elevator contractor.
   1. A j-box shall have hinged cover sized appropriately for elevator cabling to terminate on terminal blocks next to the access control panel. Provide terminal blocks for cabling from the access control panel and separate terminal blocks for cabling to the elevator control panel with connections between the two terminal blocks to create a “demarc”. Label cover of j-box with “ELEVATOR CONTROL DEMARC”. Inside cover shall be labeled to identify which terminal blocks are associated with the landing/ floor.
   2. Each landing/ floor shall have a dedicated connection to the terminal strip and shall operate independently of other landings/ floors.

L. Keyed switches: provide cabling and connections to the access control panel. Keyed switches shall not bypass the access control panel or interrupt the power to the door hardware.

## 3.02 LABELING

A. General:
   1. Labels shall be permanent typewritten labels produced by a labeling machine.
   2. Labels shall be installed on cabling at each end with wrap around labels. Ensure labels are securely fastened.
   3. Labels shall be located within 6 inches of cable termination and placed so they can be easily read.
   4. Font type shall be Arial.
   5. Labeling shall be completed prior to the substantial completion date of the project.

B. Panel Labeling:
   1. Panel ID labeling shall be placed on the front cover of the enclosure.
      a. The labeling shall be as follows:
         1) 101-ACP.1 where:
         2) 101 = MDF/IDF Room (as indicated on the Contract Drawings)
         3) –ACP.1 = Panel name and number
   2. Circuit ID label shall be on the front of the enclosures. Labeling shall contain the electrical panel and circuit number connected to the panel and power supply.

C. Battery Labeling:
   1. Labeling shall be placed on the side of the battery viewable when opening the front cover of the panel.
   2. The labeling shall be as follows:
      a. 101-B.1-July 2023 where:
      b. 101 = MDF/IDF Room (as indicated on the Contract Drawings)
      c. B.1 = Battery ID no. (per room)

d. July 2023 = Month and year of installation

## 3.03 OPEN CABLING SUPPORT INSTALLATION

A. All cabling shall be run exposed as “open cabling” in ceiling spaces and ceiling plenums, unless otherwise noted.

B. Provide all hanger supports and cable supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.

C. Cabling supports shall be spaced no further than 4’-0” apart.

D. Provide all additional cable management products as required to protect exposed cabling and complete the installation of cabling in a neat professional manner.

E. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.

F. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.

G. Cabling bundles and supports changing pathway direction shall maintain proper bend radius as to not impact the physical jacket construction of the cabling. Cabling that becomes damaged during this transition shall be replaced in its entirety.

H. Follow manufacturer’s recommendations for quantity of cables supported in J-hooks and adjustable cable supports.

## 3.04 PROGRAMMING

A. Programming of the system shall include, but not limited to:

1. Programming user/ groups, door groups, creating maps, door schedules, access cards and/or e-mail notifications as defined by the Owner.
2. The system shall be programmed with “normal” opening and closing periods for each day of the week and thus suppressing the scheduled opening/ closing reports. The system shall only report on opening/ closings outside the pre-defined schedule.
3. If a credential is presented to a reader during a time or date that is not within its programmed privileges, the door shall not be unlocked.
4. If a lost/stolen credential is presented to the reader, access shall be denied, an alarm shall be transmitted to the local control panel.
5. Forced entry detection shall be enabled at doors equipped with an internal request to exit (REX). A forced entry shall be generated immediately whenever the door is opened without authorization. Authorization shall be determined by card, REX transaction at the door, or by command from the host system as described. Doors without an internal REX device shall not report forced entry.
6. Door held open detection shall be enabled at electronic controlled doors. A door held open event shall be generated immediately when the door is held open longer than 5 seconds.
7. The system shall automatically re-lock the electronic controlled portal when the door is sensed as closed and/or whenever the 2 second door relay unlock time expires.
8. Auto operator motor (ADA button) shall be disabled when the door hardware is in a locked state from the outside without an authorized credential read. Interior ADA button shall always be enabled to operate and unlock the door hardware if the door is in a locked state. When an authorized credential is presented to the exterior card reader the access control panel/ relay shall unlock the door enable the auto operator button allowing the motor to open the door.

9. Keyed switches shall change the door hardware to a locked/ unlocked state via the access control panel. If the door hardware's state has been changed via the keyed switch, and a lockdown occurs the access control system shall change the door hardware's state to be locked, or maintain the door hardware in a locked state.
10. Provide a safety mechanism called 'First Person In' to prevent assigned doors programmed for auto unlock from unlocking at the start of a designated time zone until a valid credential is first presented by an authorized cardholder.
11. Other programming requirements shall be coordinated with the Owner and shall be provided at no additional cost to Owner.

B. System Integration:
   1. Access Control and HMI Door Control Integration
      a. Provide an output from the PLC to the input on the WAC such that the access-controlled doors can be unlocked through a button on the touchscreen.

## 3.05 PRE-TESTING

A. After Work is completed, and prior to requesting the acceptance test, Contractor shall conduct a final inspection, and an operational pre-test of all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and operational pre-test.

B. Submit written notification to the Owner's Representative and the A/E that systems have been tested, are operating properly, and are ready for Acceptance at least 21 days prior to the requested test date.

## 3.06 FINAL ACCEPTANCE

A. Contractor shall submit a request for the Acceptance test in writing to the Owner no less than twenty-one days prior to the requested test date. The request for acceptance test shall constitute a certification from the Contractor that all Work is complete and in compliance with the Contract Documents; all systems have been tested; and that all corrections have been made.

B. Acceptance test shall be scheduled during a period when the building is unoccupied and a complete system test can be accomplished. Contractor shall provide the services of no fewer than two (2) technicians to perform the acceptance test. Technicians performing the acceptance test shall have been involved in the installation of this project and shall be thoroughly familiar with all aspects of the Work. Technicians shall be equipped with portable two-way radios that will be used during the test.

C. Contractor shall provide all ladders, tools, test equipment, and other facilities needed to accomplish the Acceptance test.

D. During acceptance test, Contractor shall demonstrate all equipment and system features to the Owner. Contractor shall fully cooperate with the Owner and provide assistance with the inspection and test. Contractor shall remove and reinstall covers, open and restore wiring connections, operate equipment, and perform other reasonable work as requested by the Owner.

E. Any portions of the Work found to be deficient or not in compliance with the Contract Documents will be rejected. Owner will record any such deficiencies observed during the Acceptance test. A copy of said list will be provided to Contractor. Contractor shall promptly correct all deficiencies.

## 3.07 WARRANTY AND SERVICE

A. Contractor shall provide parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from Date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

B. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

## 3.08 TRAINING

A. Owner shall receive 4 hours of instruction in (2) 2-hour segments covering all aspects of operating the access control system.

B. Owner shall also receive assistance in configuring and inputting database to the Owner's satisfaction and until initial database is complete and functional.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. This section is a Division 28 Security Electronics section, and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplemental Conditions, Division 01 Specification sections and all Division 28 sections, apply to work of this section.

### 1.02 DESCRIPTION OF WORK

A. Furnish and install new Security Video System components, and modify and integrate existing system components as indicated on the drawings, and as required for system performance in accordance with the project requirements set forth in the specifications.

### 1.03 OPERATION

A. System Operation: The Security Video System shall be controlled through the browser software interface with a mouse or through a touchscreen interface.

### 1.04 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of Security Video System components and accessories.

B. UL Compliance and Labeling: Provide Security Video System components which are UL-listed and labeled.

### 1.05 SUBMITTALS

A. Product Data - Submit manufacturer’s data for Security Video System components including, but not limited to, roughing- diagrams and instructions for installation, operation, and maintenance, suitable for inclusion in maintenance manuals. Also include riser and wiring diagrams, and cut sheets.

## PART 2 PRODUCTS

### 2.01 TYPE 2, 5, 8 - FIXED IP CAMERA DOME

A. Provide all new IP Cameras with all hardware and mounting accessories required for mounting as intended.

B. Interior Fixed IP Camera Dome shall be Vicon V2000 Series or approved equal, see Security Electronics Schedule.

C. Cameras shall utilize H.265 video compression for streaming and recording.

### 2.02 TYPE 12 - HEMISPHERICAL IP CAMERA DOME

A. Provide all new IP Cameras with all hardware and mounting accessories required for mounting as intended.

B. Interior Fixed IP Camera Dome shall be Vicon V9360-12 or approved equal, see Security Electronics Schedule.

## 2.03 TYPE C - CORNER CELL IP CAMERA

A. Provide all new IP Cameras with all hardware and mounting accessories required for mounting as intended.

B. The Corner Cell Camera shall be Vicon model V-CELL-HD-B or approved equal.

C. The corner cell camera shall be mounted per manufacturer's instructions, including the use of an epoxy security sealant around the perimeter of the camera base where it meets the ceiling/wall to provide a waterproof installation. Vicon recommends the use of DynaPoxy EP1200 or equivalent.

## 2.04 TYPE 180 – MULTI-SENSOR IP CAMERA

A. Provide all new IP Cameras with all hardware and mounting accessories required for mounting as intended.

B. The Multi-sensor IP Camera shall be Vicon V1008-WIR-180 Series or approved equal, see Security Electronics Schedule.

C. Cameras shall utilize H.265 video compression for streaming and recording.

D. Provide with PoE++ Injector, Vicon Model VPOE-INJ-60 or approved equal.

## 2.05 TYPE 270 – MULTI-SENSOR IP CAMERA

A. Provide all new IP Cameras with all hardware and mounting accessories required for mounting as intended.

B. The Multi-sensor IP Camera shall be Vicon V1020-WIR-360 Series or approved equal, see Security Electronics Schedule.

C. Cameras shall utilize H.265 video compression for streaming and recording.

D. Provide with PoE++ Injector, Vicon Model VPOE-INJ-60 or approved equal.

## 2.06 VIDEO VIEWING WORKSTATIONS

A. Provide all Video Viewing workstations as required and shown on the drawings. Provide Vicon VLR-CLIENT-A-RK viewing station or approved equal.

## 2.07 MONITORS

A. 27" 4K LED Monitors: Dell Model P2715Q or approved equal.

B. 50" 4K LED Wall Mounted Display: Viewsonic Model CDE5010 or approved equal.

## 2.08 KVM EXTENDERS

A. Provide Black Box KVM Extenders, model KVXLCHF-100-SFP-BUN1 or approved equal as required by PC's and monitors provided. Contractor shall coordinate the KVM Extenders with provided equipment.

## 2.09 DIGITAL SERVERS

A. The video recording system is an existing Vicon Valerus System. Provide licenses for new cameras as required.

## 2.10 CERTIFICATIONS

A. UL

B. CE

C. FCC, Class A

### 2.11 WARRANTY

A. 3 years, parts and labor

### 2.12 APPROVED MANUFACTURERS

A. The Video Management System shall be Vicon's Valerus. Current version. The Network Video Recorder with internal RAID shall be Vicon Shadow VLR-XXTB-R6 or approved equal.

B. The Viewing Station shall be VLR-CLIENT(-RK) (desk-top for admin stations, rackmount for control points; 2 monitor) and VLR-CLIENT-4-RK (rack-mount; 4 monitor).

C. The Application Server and Redundant Application Server shall be Vicon VLR-APPSRV-RK.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF SECURITY VIDEO SYSTEM

A. Installation should be performed by qualified service personnel only in accordance with the National Electrical Code or applicable local codes.

B. Install Security Video System as indicated, in accordance with equipment manufacturer's written instructions.

C. Wiring and conduit arrangement shall be as shown on the drawings. Wire types shall be as recommended by the manufacturer.

D. Cameras shall be installed at locations indicated. Allow for relocation of devices up to 10 feet at the direction of the Owner or Architect/Engineer.

### 3.02 FIELD QUALITY CONTROL

A. Test all equipment and demonstrate the proper operation of the system to the Owner's representative.

### 3.03 WARRANTY

A. The products and installation shall be warranted for one year from date of final acceptance against defects in material and workmanship. Should the manufacturer's product warranties expire on a date earlier than one year following the date of Substantial Completion the contractor shall provide the balance of the warranty.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description: Design, furnish, install, and connect analog addressable, intelligent fire alarm and detection system required to form a complete coordinated system ready for operation. It shall include, but not be limited to, initiating devices, alarm notification appliances, control panels, annunciators, auxiliary control devices, power supplies, batteries, wiring and ancillary devices as shown on the Contract Drawings, as specified herein or as required to meet AHJ requirements. Contract Drawings and Specifications indicate minimum system requirements. This is a bidder-designed system and it is the responsibility of the fire alarm system vendor to provide an AHJ approved system and design.

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

### 1.02 QUALITY ASSURANCE

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

B. Authorities Having Jurisdiction (AHJs):
   1. Chehalis Fire Department.
   2. Washington State Fire Marshall.

C. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. NFPA 72, National Fire Alarm Code.
   3. UL 268, Standard for Smoke Detectors for Fire Alarm Signaling Systems.
   4. UL 864, Control Units and Accessories for Fire Alarm Systems.
   5. UL 217, Standard for Smoke Alarms.
   6. FM Global.

D. Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories. Components and systems UL listed and labeled for fire alarm systems and fire alarm and detection systems and accessories and FM approved. Comply with applicable State and local requirements.

E. Comply with applicable provisions of current NFPA 72, local building codes, and requirements of AHJs.

F. Permits and Fees:
   1. Arrange for inspections and pay for all required licenses, permits, inspections, plan review fees and any other fees.
   2. Submit complete set of fire alarm system submittals to AHJ for approval.

G. Fire Alarm and Detection System Installer Requirements:
   1. The installer shall be an authorized manufacturer's agent staffed with factory-trained and certified sales and service technicians. The installer shall have been the designated manufacturer's representative in the local market for a minimum of five (5) years.
   2. The local office of the installer shall be UL listed under the UUJS or UUFX category as a qualified fire alarm system provider.

3. The fire alarm system installer shall coordinate the installation of the fire alarm system including the preparation of shop drawings and submittals to the Authority Having Jurisdiction.
4. System design and preparation of shop drawings shall be by factory-trained personnel with the following qualifications: NICET-certified fire-alarm technician, Level II minimum.
5. System installation shall be by factory-trained personnel with the following qualifications: NICET certified fire alarm technician, Level II minimum.
6. System commissioning and testing shall be by factory-trained personnel with the following qualifications: NICET certified fire alarm technician, Level II minimum.
7. Contractor's factory trained technical representative shall respond to job site within 24 hour period for emergencies relating to system.
8. Emergency response is defined as having a technician actively troubleshoot and correct problem at job site.

H. Existing Systems: Maintain system operation during construction or provide complete fire watch as required by the local AHJ. Provide protection for existing smoke detectors near construction activity resulting creation or agitation of dust or other debris that may interfere with smoke detector functionality.

**1.03 SUBMITTALS**

A. Comply with requirements in Division 01 and Section 260500.

B. Installer Qualifications.

C. Detailed description of equipment anchorage devices on which certification is based and their installation requirements. Sequence of Operation Matrix: Provide a sequence of operation matrix which includes all trouble, supervisory and alarm conditions monitored by the system. The matrix shall be included in the shop drawing set. Provide written sequence of operation that describes the interlocks between the Fire Alarm system and all other building systems (Fire suppression, HVAC, Access Control, etc.).

D. Product Data: Submit manufacturer's technical product data for fire alarm and detection systems components including, but not limited to, roughing-in diagrams and instructions for installation, operation, and maintenance, suitable for inclusion in the Maintenance and Operation Manuals. Include riser and wiring diagrams for panel and system components.

E. Shop Drawings: Indicate equipment and device locations and connecting wiring of entire fire alarm and detection system. Include layout wiring and riser diagrams, point-to-point diagrams, and floor plans with notification appliances, raceways and wiring routing, including device addresses and strobe candela ratings.

F. Details and schedules to include:
1. Battery Calculations.
2. Notification Appliance Circuit Calculations and Loads.
3. Strobe Circuit Voltage Drops.
4. Notification Appliance Circuit Schedules.
5. Symbol Legend and Wiring Code (per manufacturer's requirements).
6. I/O Point and Relay Schedules.
7. Typical Wiring Diagrams indicating connections between panel modules and field devices and auxiliary interfaces (i.e. elevator controls, fire doors, etc.).

G. Acceptance Test Procedure: Submit a written Acceptance Test Procedure (ATP), approved by the AHJ, to Engineer at least thirty days prior to scheduled testing. The ATP shall include step-by-step procedures for performance testing every fire alarm device and system output to demonstrate functionality in accordance with specification requirements.

H. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

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

J. Operation and Maintenance Data: Comply with requirements in Section 260500. In addition, include the following:
   1. Prepare complete, simple, understandable, step-by-step, testing instructions with recommended and required testing frequency of equipment with methods for testing equipment. Include trouble-shooting manual.
   2. Prepare complete, easy-to-read, understandable maintenance instructions including the following information:
      a. Instruction on replacing components of system including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.
      b. List of equipment and components with address and phone number of both manufacturer and local supplier of each item.
   3. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   4. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
   5. Record copy of site-specific software.
   6. Submit minimum one week prior to system training.

**1.04 SYSTEM DESIGN CRITERIA**

A. Design, furnish, and install complete operable fire alarm and detection systems in accordance with the latest adopted editions of IBC, IFC, NFPA 72, and applicable city, county, and state laws, codes, and standards.

B. Drawings reflect minimum Owner requirements. The Contractor's scope of work shall include but not limited to the following:
   1. Complete fire alarm system based on the available architectural, civil, structural, mechanical and electrical drawings.
   2. Wiring systems associated with fire alarm system.
   3. Provide additional smoke detectors, heat detectors, manual alarm stations, horns, visual notification appliances, speaker notification appliances, bells, door holder controls, fire shutter and fire curtain controls, panels, power supplies, and control graphic annunciators associated with fire alarm system.
   4. Provide auxiliary controls and switches including interposing control, monitor relays, and interconnection coordination for monitoring of fire sprinkler system tamper, flow and pressure switches, mechanical equipment shutdown and smoke and combination fire/smoke damper controls, elevator controls, smoke evacuation controls, area pressurization controls.

5. Field verify locations of existing fire alarm system/fire alarm device signal transmission/interface points and document where the wiring terminations connect to other building systems. Photos shall be included in shop drawings with descriptions of fire alarm system output/control information including alarm type, zone/area of coverage, and any other information pertaining to the existing fire alarm system sequence of operations. Remake all connections to maintain the existing building systems operations.

## 1.01 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Perform functional test of existing fire alarm systems to verify the existing sequence of operations and signal transmission/interface points. Verify all existing systems that are part of the sequence of operations are in working condition. Submit documentation to show all systems, including elevator recall, elevator pressurization fans, HVAC shutdown, door release and fire smoke dampers are all functional before demolishing the existing system. If any items are not functioning the owner will review and provide direction.

B. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it “NOT IN SERVICE” until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment “NOT IN SERVICE” until removed from the building.

C. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

## 1.02 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

## 1.03 EXTRA MATERIALS AND LABOR

A. General: Furnish and install additional devices as specified herein. For each device, include rough-in and fifty feet of raceway and wiring extended from local fire alarm circuit. Location of devices as required by authority having jurisdiction or owner. Include shop drawing revisions and engineering time to update drawings for resubmittal to AHJ. Turn over any unused devices to the Owner and obtain signed receipt.

1. Smoke detectors: Quantity fifteen.
2. Duct smoke detectors: Quantity two.
3. Heat detectors: Quantity two.
4. Manual pull stations: Quantity three.
5. Wall mounted strobes: Quantity five.
6. Ceiling mounted horn/strobes: Quantity five.
7. Ceiling mounted strobes: Quantity five.
8. Wall mounted horn/strobes: Quantity five.
9. Detection Loop in fire alarm control panel: Quantity two circuits.
10. Output control loop in panel: Quantity two circuits.

11. Spare capacity on each loop: 25%.
12. Monitor Modules: Quantity five.
13. Control Relays: Quantity five.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Fire Alarm and Detection System: Subject to compliance with requirements, Notifier, Simplex Grinnell, Edwards/EST. No substitutions.

### 2.02 FIRE ALARM AND DETECTION SYSTEMS

A. General: Electrically operated, electrically supervised, fire alarm and detection system as described herein. Include control units, power supplies, alarm initiating and indicating devices, conduit, wire, fittings, and accessories required for a complete operating system.

B. Comply with requirements in Section 260533 for raceways, Section 260519 for conductors, Section 260534 for outlet boxes, and Section 260529 for supports. Minimum wire size No. 16 AWG for initiating circuits and No. 14 AWG for indicating circuits.

C. Enclose entire fire alarm system wiring in raceways.

D. Notification Appliance and Signaling Line Circuits: NFPA 72, Class B.
   1. Install no more than 100 addressable devices on each signaling line circuit. Provide isolation modules on signaling line circuits: 1) on each floor where serving multiple floors, and 2) so no more than 50 addressable devices can be out of service due to a single wiring fault.
   2. Signaling Circuitry: An open circuit in any speaker or strobe circuit shall not prevent the balance of the notification appliance circuits from operating. The control equipment shall supervise the speaker and strobe circuits to detect wiring faults.
   3. Selective Signaling: The system shall be configured to allow selective signaling by alarm type as well as by zone, floor, building, or general alarm. It shall also be capable of providing alarm signal to all zones simultaneously.

### 2.03 SYSTEM TYPE

A. Low voltage, point identification fire management system. Fire alarm and detection system shall monitor intelligent (analog) and addressable (digital) devices, traditional initiating devices, point identify alarm location, and transmit signals to monitoring agency.

B. Fire alarm control panel shall allow for loading or editing special instructions and operating sequences. System capable of on-site programming to accommodate and facilitate expansion, building parameter changes, and changes as required by AHJs. Software operations stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.

### 2.04 SYSTEM OPERATION

A. Alarm displayed on an 80 character alphanumeric display and on remote printer. Top line of characters shall be point label and second line shall be device type identifier. System alarm red LED shall flash on control panel and remote annunciator shall indicate specific device in alarm. Subsequent alarm received from another zone after being acknowledged shall flash system alarm LED on control panel and remote annunciator. LCD display and printer shall show new alarm information. Alarm tone shall occur within control panel and remote annunciator until acknowledged.

B. Alarm indicating devices silenced by entering locked control cabinet and operating alarm silence switch. Subsequent alarm condition shall reactivate signals.

C. Activation of any system smoke detector shall initiate an alarm. Alarm verification operation shall be programmed into the system for future use but not active until approved by AHJ. Alarm verification function: control panel shall reset activated detector and wait for second alarm activation. If, within 1 minute after resetting, second alarm is reported from same or any other smoke detector, system shall process alarm as described previously. Time period for alarm verification reset programmable from 0 to 60 seconds. If no second alarm occurs within alarm verification time window, system shall resume normal operation. Alarm verification shall operate only on smoke detector alarms. Other activated initiating devices process immediately. Alarm verification operation selectable by device, not just by zone. Control panel with capability to display number of times zone or detector has gone into verification mode. Information displayed on control panel and transmitted to remote printer and remote annunciator.

D. Control panel shall have a dedicated supervisory and dedicated trouble condition indicator and acknowledge switch.
   1. Activation of any standpipe or sprinkler valve tamper switch shall activate system supervisory service audible signal and illuminate LED at control panel and remote annunciator. Include differentiation between valve tamper activation and open circuits or ground fault trouble conditions.
   2. Activating acknowledge switch shall silence audible signal while supervisory service LED.
   3. Restoring valve to normal position shall cause supervisory service LED to extinguish thus indicating restoration to normal position.

E. Include manual evacuation switch at control panel to operate systems alarm indicating devices. Other control circuits not activated. True alarm processed as described previously.

F. Alarm, supervisory and trouble conditions displayed on control panel from alphanumeric display, at remote printer, and at remote annunciator. If more than one alarm, supervisory or trouble status is initiated, operator may scroll to display new alarms.

G. Control panel capable of supplying minimum 6 Amps at 24 VDC, filtered and regulated. Power supply expandable to total ampacity required by system. Initial system shall include a minimum of 25% spare capacity.

H. Functions of control panel field programmable.

I. Include connection to fire sprinkler system tamper switches, flow switches and high/low pressure alarm switches. Include connection to tamper switches in exterior vaults and post indicator valves as required.

J. Include elevator fire alarm control.

K. Include Deluge Control relay connected to the fire alarm system.

L. Include fire alarm “alarm” status dry contact for monitoring by access control system.

M. Include connection from duct smoke detector relay to fan starter control circuit. Fans shut down on local detection only. Provide interposing relays as required for HVAC shutdown. Coordinate requirements with mechanical contractor and equipment vendor. Include interface relay to control system.

N. Include connection to smoke dampers and combination fire/smoke dampers. Dampers close upon activation of smoke detectors in adjacent areas or adjacent duct detection. Include interface relay.

O. Include fire alarm system power and fire closure signal connection to fire shutters and fire curtains. Shutters close on local detection only. Coordinate requirements with shutter/curtain supplier. Include alarm release signals and coordinate requirements with door hardware supplier for the following:
   1. magnetic door holders
   2. magnetic door lock release
   3. delayed egress door hardware release
   4. turnstile release
   5. collapsible revolving doors

P. Include system output relay for alarm signaling to mechanical control system specified in Division 23.

**2.05 POWER REQUIREMENTS**

A. Include 120 VAC power from dedicated circuit for each control panel.

B. Include 120 VAC power from dedicated circuit for NAC panels. Maximum of three NAC panels per circuit. Include 120 VAC power from dedicated circuit for fire/smoke dampers. Minimum of one circuit per floor.

C. Include sufficient battery capacity to operate entire system upon loss of primary 120 VAC power in normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at end of this period. System shall automatically transfer to standby batteries upon power failure. Battery charging and recharging operations shall be automatic.

D. Circuits requiring system operating power shall be 24 VDC. Include individual fuses at control panel.

**2.06 EQUIPMENT**

A. Fire Alarm Control Panel: Modular construction with solid state microprocessor based electronics with a minimum of 25 percent spare point capacity. Include minimum 80 character minimum alphanumeric display to indicate alarms, supervisory service conditions, and troubles.

B. Control panel shall include the following:
   1. 80 character LCD display.
   2. Minimum of 2 indicating appliance circuits.
   3. Non-volatile EEPROM memory.
   4. Multiple password levels.
   5. RS232 port for programming and printer and video display unit input/output.
   6. Logic Statements.
   7. Time Controls.
   8. Sequences.
   9. Actions.
   10. Reporting of all sensors and zones.
   11. Sensitivity setting by sensor (within UL Limits).
   12. Alarm verification by point or zone.
   13. Enabling and disabling of any system device or function.
   14. Ground fault detection on all system devices and inputs.
   15. Normal and silent walk tests.

16. Cards, Components, Amplifiers etc. as required to support peripheral devices on the system.

C. Programming:
   1. Programming accomplished using a standard IBM compatible computer, either desk or laptop.
   2. Resident program stored in non-volatile EEPROM memory.
   3. System with capability to store system program on a hard disk for future changes, upgrades, and replacement.
   4. Software to allow user to reprogram system points, add system points, add or change point descriptions, and update data file. System output functions field programmable to allow custom operation.

D. Printer: Black and white laser printer to record trouble, supervisory and alarm signals and programmable changes.

## 2.07 PERIPHERAL DEVICES

A. Manual Stations: Red with raised white lettering. When station is operated, handle shall lock in protruding manner to facilitate quick visual identification of activated station. Station capable of being reset using a key. Stations which require only a screwdriver for operation not acceptable. Surface mounting boxes where required shall be matching type, steel or diecast aluminum with a red finish.

B. Manual Station Guards: Plastic guards with built-in independent local alarm. Stopper Two or approved. Provide on all manual pull stations unless otherwise noted.

C. Smoke Detectors:
   1. General: UL 268 listed and documented compatible with control equipment to which it is connected. Photoelectric type, unless indicated otherwise, with a plug-in base and visual indication of detector actuation. Detectors intelligent, addressable and with capability of alarm verification, sensitivity adjustment by detector, and “maintenance alert” circuitry. Integral addressable module.
   2. Duct Smoke Detectors: UL 268A listed.
      a. Capable of operating in air velocity range of 300 to 2,000 feet per minute.
      b. Detectors with approved duct housing for mounting exterior to duct. Weatherproof housing for exterior locations.
      c. Perforated sampling tubes extending across width of duct and end support.
      d. Integral filter system air flow monitor to indicate presence and direction of air flow through detector.
      e. Control modules and relay(s) required for equipment shutdown circuit and connection to control system. Coordinate interface with mechanical equipment and controls.
      f. Where duct smoke detector is installed above a ceiling, include remote indicator lamp and magnet activated test switch mounted on ceiling below unit. Label remote lamp and test switch. Furnish test magnet to Owner.
      g. Nameplate indicating corresponding mechanical equipment name and “supply air” or “return air”, as applicable.

D. Smoke detector guard cover: Coated protective cover fabricated from 1.5mm cold rolled steel or thicker and be U.L Listed with the associated smoke and heat detectors. It shall have a white corrosion-resistant polyester coating. Tamper resistant torx style stainless steel screws and anchors shall be used for installation. Edwards Technology SIGA-GRD or Safety Technology International model STI-8200-W or approved.

E. Heat Detectors: Addressable, analog thermal detectors. Rate of rise feature accomplished with electronic, dual thermistors. Include built-in test switch and LEDs to indicate alarm condition and polling. Thermal head shall plug-in to base. Heat detector rated for the environment in which it is to be installed (135° typical).

F. Heat Detectors, Weatherproof: Automatic resetting rate of rise type suitable for exterior installation. Include addressable module. Temperature rating as required by the installation, 135° F minimum. Fenwal horizontal Detect-A-Fire Series or approved equal.

G. Primary Notification Appliances: Provide flush mounted combination horn/strobe Audio/Visual signaling appliances where required. Specific audible and visual characteristics shall be as follows:

1. Visual Signals Fire Alarm: Furnish and install xenon strobes, synchronized in accordance with NFPA 72 chapter 4 and rated to UL 1971 standards. Strobes shall have a fixed candela rating, as follows: provide 15 candela in corridors and other areas up to 20’ x 20’, 75 candela in areas up to 40’ x 40’, and 110 candela in areas up to 50’ x 50’.
2. Audible Signals: Provide audible signal appliances designed to produce a minimum sound output of 85 dbA at 10’, or 15 dbA above ambient; whichever is greater.
3. Power Supplies: The power supplies provided for the system shall be capable of powering all notification devices simultaneously with a minimum of 20% spare capacity. Provide power supplies in increments of 8 Amps. Supervision of power supplies shall be integral to the panel. The need for separate monitor modules to supervise power supplies are not acceptable.
4. Amplifiers: The amplifiers provided for the system shall be 24 Volt 40 watt max output. Amplifiers shall be integral to the panel or in a separate enclosure next to the FACP.
5. Provide color matched surface mounted back boxes for surface mounted devices.

H. Notification Appliance Guard Covers: Clear protective cover U.L Listed with the associated notification appliances. Tamper resistant torx style stainless steel screws and anchors shall be used for installation.

I. Multiple strobes visible in a single room coordinated to flash simultaneously.

J. Water Flow Switches: Provided by Division 21 and wired by Divisions 26, 27, and 28. Coordinate requirements.Sprinkler Valve Tamper Switches: Provided by Division 21 and wired by Divisions 26, 27, and 28. Coordinate requirements.

K. Magnetic Door Holders: Provided by Division 08 and wired by Divisions 26, 27, and 28. Coordinate requirements.

L. Provide Remote LCD Annunciators. The Fire Department remote annunciator shall have a LCD readout and adjacent building map to direct fire fighters to source of alarm. Wording on map shall reflect information on digital readout. Communication between the main fire alarm control panel and the remote annunciators shall be via an RS232 link. A graphic map shall be provided adjacent to the remote LCD annunciator.

M. Provide Graphic map. The Graphic map is a floor plan representation of the facility with a full color image printed on the reverse side of 10 mil. Polycarbonate Lexan. The printed image shall be laminated to a 1/8” rigid backing with a removable adhesive for future replacement. The graphic map shall be secured in a black (standard) anodized aluminum frame and mounted with a concealed security hanging system to prevent any unauthorized removal. Obtain approval of graphic map from AHJ. Graphic map shall include the following:

1. Clearly legible room names and numbers for all floors of the building.
2. Location of the Annunciator indicated with “You are Here” notation.
3. Location of the Fire Alarm Panel.

4. Location of Sprinkler Valve Riser Room (if available).
5. Location of the Mechanical Room.
6. Location of Electrical Room.
7. Locations and zone numbers of Areas of Evacuation Assistance.

N. Plug strips: Provide switched plug strips in audio racks and podia where indicated. Plug strips shall be connected to the fire alarm system and turn off the audio amplifiers in the space in the event of a fire. Plug strips shall be rack mounted, 15 Amp, with surge suppression, front panel LED indicators, 8 total power outlets with 2 switched, and dry contact control connections. Plug strips shall be Middle Atlantic model PDC-915R-2, or equal.

O. IP Communicator:
1. Manufacturer: Notifier IPDACT-2UD, no substitutions.
2. The IP Communicator shall be UL 864 listed for signaling under Other Transmission Technologies and comply with NFPA 72 requirements.
3. The IP Communicator shall be capable of using low-cost, non-analog, digital telephone services such as cable or fiber optics.
4. The IP Communicator shall not require change to the existing panel configuration. The IP Communicator must connect directly to the primary and secondary analog panel telephone ports.
5. The IP Communicator shall work over any type of customer-provided Ethernet 10/100 Base network connection (LAN or WAN), DSL modem or cable modem.
6. Data transmits over standard contact-ID protocol must be secured with the industry's highest level of encryption (AES 512 bit).
7. The IP Communicator shall support both dynamic (DHCP) or Public and Private Static IP addressing.
8. The IP Communicator shall support dual-destination IP receiver address for high redundancy configurations. All signals are sent to a secondary address should the primary become unavailable.
9. Provide user programmable UDP ports for flexibility and compatibility with firewalls and other network security components.
10. The IP Communicator shall be compatible with the following UL 864 Ninth Edition fire alarm panels: NFS-320, NFS2-640, and the NFS2-3030.
11. Provide installation, programming and testing in strict compliance with the manufacturer's direction.
12. Communicator shall send signals to the required monitoring agency.
13. Provide communicator programming hardware, software and services for contact ID reporting as requested by the Owner and AHJ.
14. Owner's selected alarm company shall be present during dialer programming.

P. Documentation Cabinet: Provide cabinet sized so that it can contain all necessary documentation. Cabinet shall be prominently labeled "System Record Documents".

## PART 3 EXECUTION

### 3.01 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.

## 3.02 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 work of this section.

## 3.03 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.

## 3.04 FIRE ALARM AND DETECTION SYSTEM INSTALLATION

A. Install system in accordance with the Drawings and this section, applicable codes and manufacturer’s recommendations. Install wiring in compliance with NEC for power and non-power limited fire protective signaling circuits. Upon completion, certify in writing to the Owner and general contractor that system has been installed in compliance with NEC.

B. Duct Smoke Detectors: Comply with IFC, NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

C. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Install within 12” of sprinkler heads.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

F. Mounting Heights:
   1. Manual Station: Operating handle approximately 48 inches above floor.
   2. Alarm Signal Devices: Approximately 80 inches above floor to centerline.
   3. Magnetic Door Holders: 78 inches to center line except as noted.

G. Wire:
   1. Per manufacturer’s recommendations and as per NEC. Comply with requirements in Section 260519.
   2. Where required, provide wiring in metallic conduit. Comply with requirements in Section 260533.

H. Make conduit and wiring connections to equipment requiring monitoring or control. Including but not limited to sprinkler flow switches, sprinkler valve tamper switches, elevator controller, kitchen hood systems and appropriate air handling equipment.

I. Label junction boxes for fire alarm with minimum 1/4 inch letters: “FIRE ALARM”.

J. Test conductors for ground conditions before making final wiring connections. Comply with requirements in Section 260526.

K. Maintain wiring color code throughout installation. Include color code identification in the Operation and Maintenance Manual.

L. Coordinate with appropriate subcontractors for installation of equipment and devices that pertain to other work in the contract.

M. Clean dirt and debris from inside and outside of the fire alarm equipment after completion of installation.

N. Coordinate installation of duct smoke detectors with Division 23 work.

O. Install remote annunciators as indicated on the Drawings and as required by AHJ.

P. Label all conductors in fire alarm panels, terminal blocks, and large pull boxes. Each conductor shall have a unique and specific designation.

Q. All wiring shall be terminated/connected to a device, terminal block, or fire alarm panel. T-Tapping and splicing will not be permitted.

R. Wiring installed in riser conduits shall have strain relief in j-boxes so that cable and connections are maintained and not damaged.

S. Specifier Note: This is to install the RF Subsriber units. Remove reference to the owners monitoring agency if the contractor is purchasing the subscriber unit for the owner.

## 3.05 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section “Door Hardware”. Connect hardware and devices to fire-alarm system.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated air-conditioning duct systems.
2. Alarm-initiating connection to elevator recall system and components.
3. Supervisory connections at valve supervisory switches.
4. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

C. Supervisory connections at elevator shunt trip breaker.

## 3.06 MANUFACTURER’S FIELD SERVICES

A. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

B. Include operations and maintenance instructions for the Owner’s representative of devices including trouble shooting procedures.

## 3.07 FIELD QUALITY CONTROL

A. Check out of and final connections to fire alarm control panel by factory trained technicians in employ of factory authorized franchised dealer for products installed.

B. System, upon completion of installation, checked out, final connections made, and tested to initiating and indicating devices by factory trained technicians in employ of factory franchised dealer for products installed.

C. Test completed fire alarm and detection system in accordance with NFPA 72 in presence of the Owner’s representative and the AHJ. Upon completion of successful test, certify in writing to

the Owner and general contractor that system has been successfully tested and accepted by the AHJ. Include field test results in the Operation and Maintenance Manual.

## 3.08 TRAINING

A. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner. Provide hardware, software, and training to allow Owner to view and change panel programming on site and to view programming remotely.

B. A factory trained representative shall provide (1) 4-hour session to fully instruct the Owner's personnel as to correct operating testing, maintenance and troubleshooting procedures. Video tape this training session and provide copy to Owner for future reference. Schedule training with Owner in writing as least 7 working days in advance of the training date.

## 3.09 RECORD DRAWINGS

A. See Section 260500 for record drawing information. Accurately identify the final location, addresses and type of each device on drawings. Divisions 26, 27, and 28 Subcontractor shall keep a set of record drawings on site during construction and programming and shall mark-up changes made on these drawings. Transfer the mark-up information to an AutoCAD 2002-2014 format CAD file at the close of the project. Provide the Owner with the mark-up drawings, a CAD plot and CAD file on disk.

B. Provide a complete printout hard copy of the system program and an electronic backup copy or the site specific software for all future programming needs by authorized manufacturer/distributor per NFPA 72 4,5,2,3.(3).

**END OF SECTION**

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. This section is a Division 28 Security Electronics section, and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplementary Conditions, Division 01 Specifications sections and all Division 28 sections, apply to work of this section.

### 1.02 DESCRIPTION OF WORK

A. This specification covers the technical requirement for a programmable controller which can receive discrete and analog inputs and outputs. Through the use of relay ladder logic and other languages, including "C", IEC, and Derived Function Blocks, it can control discrete and analog output functions, perform data handling operations and communicate with external devices.

B. Security Systems Integrator will provide the necessary equipment to perform all functions as required to for a complete operating system. Refer to Section 28 46 20 Touch Screen Control System for additional requirements.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

A. The programmable controller, and all of the corresponding components within the family of controller products, shall be by a company who regularly manufactures and services type of equipment. This specification is based upon the M340 family of PLC’s by Square D.

B. The manufacturer shall have a fully operational quality assurance and quality control program in place and shall comply with ISO9001 standards for "Quality Systems- Model for Quality Assurance in design/Development, Production, Installation, and Servicing".

C. Complete product documentation describing installation, operation, programming and simple field maintenance shall be available.

D. The manufacturer or its authorized representative shall provide complete technical support for all of the products. This shall include headquarters or local training, regional application centers, local or headquarters technical assistance and a "1-800" phone line.

### 2.02 SYSTEM

A. The system shall consist of rigid components designed specifically for industrial environments. A complete system shall consist of one or more racks containing I/O modules, interconnected by power and data cables.

B. All products shall be designed, manufactured, and tested in accordance with recognized industrial standards.

C. The controller CPU shall be modular. When mounted on the system rack, the CPU shall not occupy more than one available slot.

D. The I/O system shall be modular. Each module shall consist of one or more printed circuit boards attached to a durable plastic face assembly. When mounted on the system rack, most I/O modules shall not occupy more than one available slot.

E. There shall be a variety of sizes of racks available, ranging from 2-slot to 16-slot configurations. The primary rack shall hold a power supply and a CPU, plus interface and I/O modules as required to meet the application. An expansion rack with power supply shall be available, allowing a second rack to be connected to the primary rack via a cable to utilize the primary rack's communications controller or CPU. The system provided shall have a minimum of 30% rack space available for future system changes.

F. The PLC system shall be mounted in a wall mounted enclosure.

G. The system shall incorporate a modular design using plug-in assemblies.

H. Wherever possible, all assemblies and sub-assemblies performing similar functions shall be interchangeable.

I. The system design shall accommodate the replacement of assemblies without having to disconnect field wiring. Universal removable terminal strips shall be available to connect field wiring to the individual circuit board assemblies.

J. Universal module faceplates with color-coded, slip-in labels shall be available. The outside label features both color-coding for module specification and labeling space for I/O point identification. The inside label shall feature a detailed wiring diagram complete with the module catalog number and description.

K. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings, each of which indicates the manufacturer's catalog number and a product manufacturing date code.

L. The PLC systems shall share features with the manufacturer's low end PLCs and distributed small point count PLC's, such as the Modicon Momentum series of PLC's.: Common Language features Communications Protocols, identical programming, and common Operator Interfaces.

## 2.03 ENVIRONMENTAL CONDITIONS

A. All components of the controller system shall meet the following:
   1. Storage Conditions: TEMPERATURE -40 to 85 degrees C
   2. Operating Conditions:
      a. TEMPERATURE 0 to 60 degrees C, 0 to 55 degrees C for 80486DX based CPU
      b. HUMIDITY 5 to 95% relative humidity, non-condensing
      c. POWER INTERRUPTION Operate through a total loss of power for 17.6 msec.

## 2.04 CENTRAL PROCESSING UNIT (CPU)

A. New PLC's with processors shall be installed in most buildings. New PLC's shall be Modicon M340 PLC with a BMXP 342000 CPU and a separate ethernet card.

B. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O systems.

C. The existing main CPU in the security electronics room under main control shall be reused. The existing hot standby configuration shall be removed and a single processor configuration shall be utilized.

D. The CPU family shall allow for user program transportability from one CPU model to another.

E. The CPU shall provide extensive diagnostic information through the use of an Alarm Processor, which is specialized firmware designed to receive and process faults. The diagnostics shall provide information on the status of the CPU, memory, communications, and I/O.

F. The alarm processing functionality shall time-stamp and log system and I/O faults into dedicated fault tables respectfully.

G. All diagnostic information shall be accessible at an optional programming workstation which attaches to the CPU. A diagnostic CRT page shall provide information which identifies the nature of the fault, the absolute memory or I/O address of the fault, and the date and time of occurrence of the fault. All diagnostic information shall be accessible to optional host communications interfaces.

**2.05 I/O**

A. Provide I/O modules and backplanes in quantities required.

B. Provide all communications interface cards required. These include RS-232, RS-422, RS-485, Modbus, Modbus Plus. Include all software and programming required to implement each interface with the PLC.

C. Provide ModbusIP module with Prosoft ModbusIP to Bacnet converter, model PS-QS-2x10-F. Connect to lighting control system to provide cell level lighting control through the touchscreen control system.

D. Provide ModbusIP module with Prosoft ModbusIP to Bacnet converter, model PS-QS-2x10-F. Connect to lighting control system to provide cell level HVAC control through the touchscreen control system.

E. Provide contact closure outputs to lighting control as indicate on the drawings. Lighting control for selected areas will be controlled through the touchscreen.

**2.06 MOMENTUM MODULES**

A. Provide Momentum Modules at locations shown in quantities as required for the inputs and outputs.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

A. The PLC components shall be installed on a backplane which is fitted into the rack enclosure or in a wall enclosure.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. This section is a Division 28 Security Electronics section, and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplementary Conditions, Division 01 Specification sections and all Division 28 sections, apply to work of this section.

### 1.02 DESCRIPTION OF WORK

A. Provide a complete and operating touch screen control system consisting of consoles, door control, intercom system, and security video system.

B. Provide associated circuitry to operate door locks. Verify with door hardware supplier requirements of the door locks and provide all materials and labor required to accomplish intended function.

C. Coordinate all power connections, uninterruptible power supply, conduit and wire, and circuit breakers required in emergency power panels to satisfy the power requirements of the system in this Division whether specifically shown or not.

### 1.03 QUALITY ASSURANCE

A. All systems shall comply with applicable federal, state, and local building codes. Conduit and wire installation shall comply with all of the provisions of Division 28. All equipment shall be Underwriters Laboratories (UL) approved if applicable.

B. The Integrator shall develop the specific graphical touch screen software in-house and shall not subcontract out any of the software or hardware engineering.

### 1.04 SUBMITTALS

A. Hardware Submittal:
   1. After award of a contract, the Security System Integrator (SSI) will submit in accordance with Division 28, copies of shop drawings showing complete details of each custom-built control panel. Layout drawings of control panels using off-the-shelf equipment will also be submitted for approval.
   2. Submit in accordance with Section 28 01 00 copies of data sheets and equipment lists showing all equipment and components to be used in the detention touch screen electronics system.
   3. Submit complete line voltage and low voltage wiring including devices and logic diagrams.

B. Software Submittal:
   1. The Security Systems Integrator shall provide a list of each software developed graphic panel and its layout in detail. The first submittal shall show the proposed background, buttons, icons, colors, etc., and shall have an attached description of how the graphic screen flows with the screens ahead and behind it. This submittal shall also include:
      a. A list of all the icons to be used.
      b. Include colors to be used, fonts, font size, borders, fills, fill colors, flashing colors, and flashing rates.
   2. The software screens will be developed specifically for this project. All aspects of the screens require the approval of the Architect.

3. After the first submittal of the software development process is approved the SSI shall fully implement the approved design. The second submittal shall consist of a full scale demonstration of the developed graphic panels. This shall occur at the facility of the SSI prior to shipping the system to the project. The Owner, Architect and Engineer will review the developed system. Any requested changes shall be implemented promptly.

### 1.05 VENDORS

A. All work in this section shall be accomplished by a single approved firm, specializing in the type of work required so that there will be undivided responsibility for the design, fabrication, coordination, installation, performance, and warranty of the electronic touch screen system.

### 1.06 QUALIFICATIONS

A. The Security System Integrator shall be licensed and shall employ persons who are licensed by the State of Washington as limited energy technicians. Electricians licensed by the State of Washington shall be employed to install all conduit, wire, and perform any high voltage work required.

B. The System Security Integrator shall be able to provide software support from their principal location and provide four hour turn around on telephonic and e-mail service requests.

## PART 2 PRODUCTS

### 2.01 HARDWARE

A. Ethernet Switches: Contractor provided; contractor installed.

B. Touchscreen Computers: Contractor provided; contractor installed. Contractor shall load and configure touchscreen control software.

C. Touchscreen: The touchscreen shall be Viewsonic model TD2760 or approved equal.

### 2.02 SOFTWARE

A. Provide current version software and licenses in quantities as required.
   1. Software Package: Vijeo Citect by Schneider Electric and Unity Pro for PLC programming.
   2. Contractor to program approved equals.
      a. GE Cimplicity
      b. Wonderware by Schneider Electric
   3. Provide licenses as required.

### 2.03 PROGRAMMING

A. The system programming shall be done at the PLC level. All logic possible will be resident in the PLC. The touch screen and touch panel computers shall provide a graphical interface. The touch screen or touch panel PC shall not provide the control logic.

B. All logic programming shall be fully commented and labeled to facilitate debugging and programming changes.

C. All system passwords, for all levels of system access, shall be provided to the owner, in a manner as prescribed by the owner. Disclose any factory set or contractor-installed passwords.

### 2.04 SYSTEM RESPONSE TIME

A. The PLC and computer combined time delay between touching the screen icon and the activation of the associated output (CCTV, door lock, etc.) and the icon changing color to indicate the change in status shall not exceed 250 milliseconds.

B. The maximum time delay to leave one screen and fully generate the next screen shall be 500 milliseconds.

C. The maximum time delay from touching a system icon to having a stable selected picture on the video monitor shall be 500 milliseconds.

D. System response time shall not degrade below these standards under heavy system traffic or any number of pending events.

## PART 3 EXECUTION

### 3.01 TRAINING

A. System Operator Training: Provide training for the correctional officers in the proper operation of programmed new features of the touch screen control system. Provide training and assistance as required during the week after the system is turned over to the Owner.

### 3.02 OPERATION

A. The touch screen control system shall be programmed to implement the functions described in specification 28 46 21.

### 3.03 SYSTEM ADAPTATION

A. The system shall be delivered as specified. Any modifications of the system required to achieve the specified performance shall be provided at no cost to the owner.

B. To make any adaptations requested by the owner the Security System Integrator shall include in the bid a minimum of twenty (20) hours of in-shop program customization time, plus two (2) trips to the site to install owner requested changes to the system programming after the project has been accepted.

C. This adaptation shall occur during the system warranty period. The SSI and the architect will account for this time allowance. Additional programming time shall be provided by change order; un-expended time from the specified allowance will expire at the termination of the warranty period, or the owner may convert that time to additional training to be provided by the contractor.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. This section is a Division 28 Section, and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplementary Conditions, Division 01 Specification sections and all Division 28 sections, apply to work of this section.

### 1.02 INTENT

A. The intent of this contract is to provide an integrated intercom and communications system for the project.

B. The system to include the following functions:
   1. Door control intercom
   2. Cell intercom
   3. Administrative intercom
   4. Intercom station audio monitoring

C. System descriptions include descriptions of intercom custom functions that require custom programming and integration. Include all custom equipment and programming in the base bid.

D. The system to integrate with the following other security and communication systems to form a comprehensive facility management network:
   1. PLC door control system
   2. Touch screen graphics control system
   3. Closed circuit television system
   4. Include all functions necessary to implement the security system descriptions

### 1.03 SCOPE OF WORK

A. Work of this contract includes the supply and installation of an integrated intercom and communications system as specified herein. Provide custom stations with multiple call-in buttons, phone jacks and all custom integration required. Comply with all system description requirements. See specification section 28 46 21.

B. The system is to include all equipment, installation, installation materials, set up, and testing to form a complete operating system.

C. Independent system functions and integrated system functions to be fully verified as part of system testing and commissioning.

D. Work of this contract also includes the provision operating and maintenance manuals, training and demonstration, and extended warranty.

### 1.04 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

A. The following products are required to facilitate the system installation, but are specified in other sections:
   1. Equipment racks and accessories
   2. Terminal boards and cabinets
   3. Device outlet boxes
   4. AC power sources for system equipment.

## 1.05 SYSTEM DESCRIPTION

A. The integrated intercom and communications system to include the following components:
   1. Digital Communications Controllers (DCCs)
   2. Digital Communication Expanders (DCEs)
   3. Talkback Expanders (TBEs)
   4. Page Zone Expanders (PZEs)
   5. MicroComm DXL Administrator Software for configuring and maintaining the system
   6. Intercom master stations
   7. Telephone set master stations
   8. VoIP intercom master stations
   9. Intercom stations
   10. Auxiliary power supplies

B. Digital Communication Controllers, Digital Communication Expanders and Talkback Expanders to be interconnected to form intercom exchanges capable of standalone local operation. Each Digital Communication Controller to be capable of supporting up to four Digital Communication Expanders and/or Talkback Expanders.

C. Intercom system to consist of up to forty-eight exchanges networked together to form a fully integrated operating system. System capacity to allow for up to:
   1. 480 analog master stations and 624 VoIP master stations
   2. 7680 analog intercom stations and 9600 VoIP intercom stations

D. Intercom system to include ability to be controlled by touch screen computers, graphic control panels, and switch selector panels.

## 1.06 PERFORMANCE REQUIREMENTS

A. System frequency response: 300 to 3,500 Hz.

B. Intercom station output: 82 dB SPL at 3 feet with 82 dB SPL input at face of transmitting station.

C. All system equipment to comply with the radiation limits for Class A digital devices of FCC Rules Part 15, Subpart B.

## 1.07 QUALITY ASSURANCE

A. Intercom system equipment is to be designed and manufactured in accordance with ISO-9001 2000 Quality System Standard.

B. Manufacturer’s quality control program to be registered in accordance with the above noted standard.

## 1.08 OPERATION AND MAINTENANCE MANUALS

A. Contractor is to provide operation and maintenance manuals for system supplied under this contract as provided in Section 280100.

B. Operation and maintenance data to include:
   1. Contractor Design Data including:
      a. System design criteria
      b. System and controls descriptions
      c. System and controls schematics
      d. Site specific operating instructions

2. Installation Instructions: manufacturer's printed instructions describing manufacturer's recommended installation procedures.
3. Operating Instructions: manufacturer's printed instructions describing proper operation.
4. Equipment Identification: Nameplate information for each piece of equipment.
5. Maintenance Instructions: manufacturer's printed instructions describing manufacturer's recommended maintenance.
6. Spare Parts Lists: parts listing of spares provided under the Contract.
7. Suppliers and Contractors List: list of contractors and suppliers who supplied and installed equipment, systems, materials or finishes. Includes company name, address, and telephone number.
8. Tag Directories: directory identifying tag number and equipment description and location.
9. Drawings List: list of contract and system drawings.
10. Product Data: manufacturer's product data for equipment, systems, materials and finishes.

## PART 2 PRODUCTS

### 2.01 APPROVED MANUFACTURERS

A. The following manufacturers and their named products are approved for use in this Work:
   1. Harding Instrument Co. Ltd.
   2. MicroComm DXL
   3. Approved Equal

### 2.02 DIGITAL COMMUNICATION CONTROLLERS (DCC's)

A. Digital Communication Controllers to each form an intercom exchange capable of independent local operation. Exchange capacity to be increased by connecting up to four Digital Communication Expanders to each DCC.

B. Multiple DCC's to be networked together via digital audio trunks and/or Ethernet data networks to form larger systems. VoIP enabled systems shall utilize IEEE 802.1p/Q Quality of Service (QoS) compliant Ethernet networking equipment.

C. Each DCC to include:
   1. A Process Control Card (PCC)
   2. A Master Control Card (MCC)
   3. Two Station Control Cards (SCCs)
   4. A front panel keypad/display for system setup and maintenance.
   5. A 110 VAC, 60 Hz power supply for internal functions.

D. Process Control Card:
   1. Process Control Card to contain system configuration and data, control exchange operations and switching, and provide exchange network ports.
   2. Process Control Card to include:
      a. USB network ports for exchange expansion.
      b. Ethernet network ports for system expansion and external control by touch screen computers and graphic control panels.
      c. Fiber optic or copper digital audio trunk ports. (not required for VoIP over Ethernet audio trunking)
      d. Two serial ports.
      e. An internal modem for transmitting and receiving data over a telephone line.

E. Master Control Cards:
   1. Include ports for any combination of two intercom or telephone set master stations.
   2. Include two line level audio inputs with status and control.
   3. Include two line level audio outputs with status and control.
   4. Convert incoming audio signals to digital format and outgoing signals to analog format.
   5. Intercom master station audio, press-to-talk and hook switch status transmitted over two single shielded pair cables with wiring supervision to detect open circuit and short circuit faults.
   6. Telephone set master station functions transmitted over a single wiring pair.

F. Station Control Cards:
   1. Each provides sixteen half-duplex intercom station ports which can be employed in adjacent pairs for full duplex devices.
   2. Provide an interface for intercom stations. Units to convert incoming audio signals to digital format and outgoing signals to analog format. Each channel to monitor the status of up to two (2) switches associated with each intercom station.
   3. Each card interfaces with 16 half-duplex channels. Each channel includes a separate audio power amplifier for non-blocking call operation and sixteen (16) independent software controlled volume settings.
   4. All station audio, switch, and power functions on 400-Series and 401-Series cards to be transmitted over a single shielded pair cable with supervision to detect open circuit and short circuit faults.

## 2.03 DIGITAL COMMUNICATION EXPANDERS (DCE's)

A. Digital Communication Expanders to provide master station and intercom features similar to the DCCs to facilitate exchange expansion.

B. Each DCE to include:
   1. A Process Control Card (PCC) without exchange controls or network functions.
   2. A Master Control Card (MCC)
   3. Two Station Control Cards (SCCs)
   4. A 110 VAC, 60 Hz power supply for internal functions.

## 2.04 TALKBACK EXPANDERS (TBEs)

A. Talkback Expanders to provide 8 amplified paging outputs that can drive 25 Vrms loudspeaker circuits.

B. Each TBE is to:
   1. Provide 5 watts output per channel
   2. Allow adjacent channels to be bridged to obtain higher power.
   3. Provide talkback capability on all channels.
   4. Include Audio Level Alarm capability on all channels.

## 2.05 PAGE ZONE EXPANDERS (PZEs)

A. Page Zone Expanders to provide 3 page inputs (from an audio amplifier) with each input having 6 selectable relay controlled outputs

B. Each PZE input to include:
   1. 1 relay controlled output for each input that can be used to key an audio amplifier.

## 2.06 ADMINISTRATOR SOFTWARE

A. Administrator Software to function on a standard PC to support system configuration, diagnostics, maintenance, and logging but not be required for system operation.

B. Administrator Software to employ Windows features including views of system tree structure, tables of devices, screens for system settings and adjustments, and tables of operational data.

C. Configuration features to include:
   1. Creation of overall system architecture.
   2. Creation of multiple device templates.
   3. Copy and paste functions with auto-numbering and auto-assignment to create device schedules.
   4. Configuration error detection and alerts.
   5. Device naming and call routing functions.
   6. Device setting and performance functions.

D. Diagnostic and Maintenance features to include:
   1. Verification of system configuration and installation.
   2. Verification of system networks.
   3. Verification of device connections.
   4. Verification of system operation.
   5. Diagnostics via modem or Ethernet ports.

E. Logging features to include:
   1. Display of system activity with filtering options.
   2. Search by time and date.
   3. Search by device.
   4. Search by parameter.

## 2.07 DISCRETE I/O MODULES

A. Each Discrete I/O (input/output) module is to interface up to 48 contact closure type input monitor points and 48 solid-state 16 relay output control points. Outputs are to be current sink form C contact type.

B. Inputs are to be supervised (*non-supervised*) for open circuit and short circuit faults in field wiring. With terminating resistors, each supervised input is able to monitor two contact points for a total of 96 inputs.

C. DIO modules to be rack or wall mounted.

## 2.08 VoIP TOUCH SCREEN INTERCOM MASTER STATIONS

A. Desktop loudspeaker/microphone unit is to include compact, slim line bottom plate with stainless steel face, and rubber shock isolation mounting feet.

B. Unit to include a flush mounted electret microphone, front mounted loudspeaker, front mounted rotary volume control, and front access headphone jack.

C. Unit to include support for a privacy handset.

D. Unit to include a line level audio output of the speaker signal.

E. The network connection shall be a 10/100Mbps (RJ45 connector) Ethernet port with support for IEEE 802.3af inline power. A separate power connector shall also be provided in case an IEEE 802.3af compliant Ethernet switch is not available. The master station shall also provide support for the IEEE 802.1p/Q Quality of Service (QoS) standard.

F. The VoIP Touch screen Master Station shall be Harding model TMM-640 or approved equal.

### 2.09 ANALOG INTERCOM STATIONS

A. Intercom stations are to be designed for mounting on standard 2-gang outlet boxes. Faceplates to be constructed of 11-gauge brushed stainless. Internal steel offset grille to restrict inserting objects through speaker grille. Stations to be ruggedly constructed and resistant to damage from soil and sprays.

B. Each intercom station is to incorporate an internal loudspeaker, microphone preamplifier and function multiplexing circuitry. One pushbutton(s) is to be provided on each station. Pushbuttons to be software assignable for placement of call requests or control of auxiliary functions.

C. Pushbuttons to be vandal resistant and of stainless steel. Switch to have positive tactile action with 1 million-operation lifetime.

D. Loudspeakers to be waterproof mylar cone type.

E. All intercom station functions to be transmitted over a single shielded pair cable. Stations to be provided with MTA type insulation displacement connector that requires no wire stripping for installation. Intercom stations shall be Harding 400 Series.

F. Outdoor intercom stations are to be identical in all respects to standard intercom stations except that all metal plates and hardware to be stainless steel, and internal circuitry and components to be conformally coated.

### 2.10 DISCRETE INPUT/OUTPUT

A. Controller module provides 18 open drain outputs and 18 discrete inputs that can be software configured for either supervised or non-supervised operation.
   1. Control and monitoring of the discrete inputs and outputs provided through an Ethernet connection.
   2. Expander units provide 24 open drain outputs and 24 discrete inputs that can be software configured for either supervised or non-supervised operation.
   3. Up to three expander units can be daisy chained to a controller module.

### 2.11 LOUDSPEAKERS

A. Loudspeakers to be nominal 8” diameter dual cone type units. Loudspeakers to incorporate 10-ounce permanent magnet and include a 10-watt multi tap transformer for use on 25 volt and 70 volt constant voltage type distribution systems.

B. Each loudspeaker to be provided with a security baffle plate and flush or surface mounted enclosure, as required. Baffle and enclosure to be all metal construction and finished in polar white baked on enamel. Provide Atlas C10AT72 speaker, 193-8 Backbox, VP161A-R8 baffle or approved equal.

### 2.12 HANDS-FREE VISITING INTERCOM OR PASS THRU INTERCOM

A. Shall be Haven SC 300 or SC 600 or approved equal.

## PART 3 EXECUTION

### 3.01 GENERAL INSTALLATION PROVISIONS

A. Inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in and acceptable manner.

B. Verify the accuracy of all dimensions, allowances, and clearances on site prior to commencing with any work that may be affected by those dimensions, allowances, and clearances.

C. Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in the Contract Documents.

D. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.

E. Supervise construction activities to ensure that no part of the Work, completed or in progress is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

F. Precautions shall be taken to guard against electrostatic and electromagnetic susceptibility and interference.

G. Provide adequate ventilation for all heat radiating equipment.

H. Install equipment so as to provide maximum safety to the operating and maintenance personnel.

## 3.02 METHOD OF WORK

A. Work to be performed by fully competent technicians in a thorough manner.

B. All workmanship to be of the highest quality and meet recognized standards of craftsmanship.

C. Areas of installation deemed not acceptable by the Owner to be redone at the Contractor's expense.

## 3.03 PROTECTION OF EXISTING PROPERTY

A. Be responsible for protecting all existing property including floors, walls, ceilings, furniture, and furnishings from damage, dust and other construction related activities. Provide all necessary dust covers and protective pads required for performance of the Work.

B. Remove all debris and protective coverings at the end of each work period. Leave premises in condition found at start of work in each room or area of work.

C. Except for scheduled activities, do not inconvenience user due to construction operations.

## 3.04 INSTALLATION

A. Provide complete integrated intercom and communications system as indicated on the drawings and specified herein.

B. All material furnished shall be new and conform to the applicable requirements of the Underwriters Laboratories and the National Standards Institute.

C. Unless otherwise noted, all wiring is to be installed in conduit or wireways.

D. If more or larger conduit is required than exists or is indicated on the drawings, allow for such additional conduit in contract price.

E. All system equipment to be contained within equipment racks, cabinets, or closets. If more or larger racks or cabinets are required than exist or are indicated on the drawings, allow for such additional equipment racks and cabinets in contract price.

F. All system equipment and field devices to be held securely in place. Fastenings and supports shall be selected to provide a safety factor of three.

G. All system equipment equipped with plug in power connectors to be connected to a dedicated receptacle. Do not use tap connectors for plugging in multiple plugs into a single receptacle.

H. All cable within equipment racks, cupboards, and cabinets, or on backboards, to be neatly bundled and secured.

I. Wires shall not be nicked, have strands removed, or have frayed strands when removing insulation or terminating.

J. Factory manufactured interface cables to be provided for each field interface board. Terminal blocks to be provided in cabinet or on backboard for factory cable interface to field wiring.

K. Wiring shall be executed in strict adherence to standard broadcast practices.

L. Color identification of wiring:
   1. Identify wiring by continuous insulation color.
   2. Where multi-conductor cables are used, use the same color-coding system for identification of wiring throughout.

M. Maintain uniform phasing and color-coding throughout system.

N. Name identification of wiring:
   1. Identify wiring at all equipment locations, pull boxes, junction boxes and outlet boxes.
   2. Develop a uniform identification scheme for use throughout the system.
   3. Record wire name identification on all applicable drawings and provide wiring tables within the operating and installation manuals.

O. Use one of the following marking materials:
   1. Heat shrink sleeves.
   2. Clear plastic tape wrap-on strips with designated labeling section.
   3. Slip-on identification bead markers or sleeves.

## 3.05 TESTING, ADJUSTING, AND BALANCING

A. Except where otherwise specified, arrange and pay for testing, adjusting and balancing of system.

B. If test results do not conform to applicable requirements, repair, replace, adjust, or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

C. Log and tabulate test results on appropriate test report forms and as specified.

D. Submit forms to Owner prior to use.

E. Submit copy of completed test report forms to Owner immediately after tests are performed.

F. Insert a copy of completed test report forms in each copy of the operating and maintenance manuals.

G. Testing, adjusting, and balancing to verify the full and proper operation of each system component and integrated function.

## 3.06 DEMONSTRATION AND TRAINING

A. Provide demonstration and instruction sessions to familiarize Owner’s operation and maintenance personnel with systems and their operation and maintenance.

B. Establish agendas for demonstration and instruction sessions in conjunction with the Owner. Coordinate scheduling of sessions with the Owner.

C. Provide 4-hour seminars to demonstrate operation of the systems.

D. Provide 4-hour technical seminars to demonstrate configuration, troubleshooting, repair and maintenance of the system.

**END OF SECTION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Preparing subgrades for walks, pavements.

B. Subbase course for concrete walks.

C. Subbase course and base course for asphalt paving.

D. Excavating and backfilling for utility trenches.

### 1.02 REFERENCE STANDARDS

A. Standard Specification for Road, Bridge, and Municipal Construction as amended by City of Chehalis Standards. Hence forth referred to as Standard Specifications.

B. AASHTO M 145 - Standard Specifications for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

C. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

D. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort

E. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes - Unified Soil Classification System

F. ASTM D 2940 - Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways

### 1.03 SUBMITTALS

A. See Section 01 33 00, Submittal Procedures, for submittals.

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on actual materials used.

D. Compaction Density Test Reports.

### 1.04 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

B. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

C. Final Backfill: Backfill placed over initial backfill to fill a trench.

D. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

E. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

F. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

G. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

H. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

I. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and

replacement material will be paid for according to Contract provisions for changes in the Work.

J. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

K. Fill: Soil materials used to raise existing grades.

L. 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.

M. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

N. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

O. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where permitted.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

## PART 2 PRODUCTS

### 2.01 FILL MATERIALS

A. General Fill Complying with City of Chehalis Public Works

B. General: **Provide imported borrow soil materials**. Native soils are expected to be Unsatisfactory soils.

C. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

D. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups. 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

E. Bedding material shall conform to section 9-03.16 of standard specification for road, bridge, and municipal construction as amended by City of Chehalis Standards.

F. Bank run gravel for trench backfill shall conform to 9-03.19 Bank Run Gravel for Trench Backfill of standard specification for road, bridge, and municipal construction as amended by City of Chehalis Standards

G. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

H. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

I. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

### 2.02 SOURCE QUALITY CONTROL

A. Provide materials of each type from same source throughout the Work.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that survey benchmarks and intended elevations for the work are as indicated.

### 3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate existing utilities that remain from damage.

C. Protect benchmarks; survey control points; existing structures; fences; sidewalks, and curbs from excavating equipment and vehicular traffic.

D. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Architect.

E. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

### 3.03 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

### 3.04 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.05 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: As indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of

pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

D. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

## 3.06 SUBGRADE INSPECTION

A. Proof-roll subgrade below pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

## 3.07 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

## 3.08 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Place and compact initial backfill of [subbase material] [satisfactory soil], free of particles larger than [1 inch (25 mm)] <Insert dimension> in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

D. Place and compact final backfill of satisfactory soil to final subgrade elevation.

E. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

## 3.09 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

C. Under grass and planted areas, use satisfactory soil material.

D. Under walks and pavements, use satisfactory soil material.

## 3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

## 3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) n loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 95 percent.

2. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.

3. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

## 3.12 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).

2. Walks: Plus or minus 1/2 inch (13 mm).

3. Pavements: Plus or minus 1/2 inch (13 mm).

## 3.13 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.

2. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than [95] <Insert number> percent of maximum dry unit weight according to [ASTM D 698] [ASTM D 1557].

## 3.14 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

## 3.15 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

D. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

## 3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES:

A. Cold milling of existing asphalt pavement.

B. Hot-mix asphalt patching.

C. Hot-mix asphalt paving.

D. Hot-mix asphalt overlay.

### 1.02 RELATED REQUIREMENTS:

A. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

### 1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.04 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material.

### 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by WSDOT.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Standard Specifications for road asphalt paving work.

## PART 2 - PRODUCTS

### 2.01 PRODUCTS AGGREGATES

A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: ASTM D 1073 sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: ASTM D 242/D 242M rock or slag dust, hydraulic cement, or other inert material.

### 2.02 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22. Retain "Tack Coat" Paragraph below if required. Tack coat is usually diluted in equal amounts of water and emulsified asphalt. It is usually applied to vertical surfaces of curbs, gutters, cold pavement joints, and structures in the pavement that will be in contact with hot-mix asphalt. Tack coat is also applied to existing pavement surfaces to bond new hot-mix asphalt overlays.

B. Tack Coat: ASTM D 977 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

### 2.03 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles, or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

### 2.04 MIXES

A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent or more than 25 percent by weight.

B. Surface Course Limit: Recycled content no more than 10 percent by weight.

C. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by WSDOT; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course:
3. Surface Course:

## PART 3 - EXECUTION

### 3.01 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth per plan.
2. Patch surface depressions deeper than 1 inch (25 mm) after milling, before wearing course is laid.

### 3.02 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

C. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

D. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

E. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

### 3.03 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

## 3.04 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Spread mix at a minimum temperature of 250 deg F.
   2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

## 3.05 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
   3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
   4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

## 3.06 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

D. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

E. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

F. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

## 3.07 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch (13 mm).
   2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

C. Base Course: 1/4 inch (6 mm).

D. Surface Course: 1/8 inch (3 mm).

E. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

## 3.08 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

## 3.09 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

**END OF SECTION**

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 colored concrete paving.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321313 "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, and stamped detectable warnings.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and other paving or adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and decorative concrete paving construction practices.

2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Decorative concrete paving Installer.
e. Manufacturer's representative of decorative concrete paving system.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern or texture selection.

C. Samples for Verification: For each type of exposed color, pattern, or texture indicated.

D. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches.
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. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on decorative concrete paving mixtures.

1.9 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms steel reinforcement and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less. Do not use notched and bent forms.

B. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, deformed.

B. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, deformed bars; assembled with clips.

C. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.

D. Joint Dowel Bars: ASTM A 615/A 615M, plain-steel bars. Cut bars true to length with ends square and free of burrs.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I
2. Portland Cement: ASTM C 150/C 150M, white portland cement Type I
3. Fly Ash: Not allowed.
4. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
5. Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, portland blast-furnace slag cement.

C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S uniformly-graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. White masonry sand.

D. Air-Entraining Admixture: ASTM C 260/C 260M.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A, colored.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D, colored.
3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.

F. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis. Scofield lithochrome colored concrete hardener with sealant, color as indicated on plans.

G. Water: Potable and complying with ASTM C 94/C 94M.

2.5 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

B. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

2.6 SURFACE COLORING MATERIALS

A. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

B. Pigmented Powder Release Agent: Factory-packaged, dry combination of surface-conditioning and dispersing agents interground with color pigments that facilitates release of stamp mats. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

C. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation that facilitates release of stamp mats and texture rollers.

2.7 STAIN MATERIALS

A. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.

B. Penetrating Stain: Water-based, acrylic latex, penetrating stain with colorfast pigments.

2.8 CURING AND SEALING MATERIALS

A. Curing Paper: Non-staining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C 171.

B. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B, manufactured for colored concrete.

1. For integrally colored concrete, curing compound shall be pigmented type approved by coloring admixture manufacturer.
2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

D. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.

E. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.

F. Clear Acrylic Sealer: Manufacturer's standard, waterborne, non-yellowing and UV-resistant, membrane-forming, medium-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 15 percent solids by volume.

G. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving surface.

2.9 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, non-load bearing for bonding hardened or freshly mixed concrete to hardened concrete.

D. Polyethylene Film: ASTM D 4397, 1 mil thick, clear.

2.10 CONCRETE MIXTURES

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

C. Cementitious Materials: Use pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent in portland cement in concrete as follows:

1. Pozzolan: 25 percent.
2. Slag Cement: 50 percent.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 3 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

E. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

H. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

I. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 3000 psi.
2. Maximum W/C Ratio at Point of Placement: 0.50
3. Slump Limit: 4 inches plus or minus 1 inch.

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M[ and ASTM C 1116/C 1116M]. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd. increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

## 3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

## 3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

## 3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent decorative concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

   a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within 3 inches in both directions from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

## 3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.8 INTEGRALLY COLORED CONCRETE FINISH

A. Integrally Colored Concrete Finish: After final floating, apply the following finish:

1. Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/8 inch deep with a stiff-bristled broom, length-wise of rectangular concrete sections to mimic a wood grain finish.

B. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake hardener at a rate of 100 lbs. / 100 sq. ft. unless greater amount is recommended by manufacturer to match paving color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
3. After final power floating, apply the following finish:

a. Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Pigmented Powder Release Agent: Uniformly distribute onto dry-shake-hardened and still-plastic concrete at a rate of 3 to 4 lbs/100 sq. ft.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing

operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Compound: Apply immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

1. Cure integrally colored concrete with a curing compound.
2. Cure concrete finished with pigmented mineral dry-shake hardener with a pigmented curing compound.

F. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

G. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

## 3.10 STAINING

A. Newly placed concrete paving shall be at least 14 days old before staining.

B. Prepare surfaces according to manufacturer's written instructions and as follows:

1. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.

    a. Do not use acidic solutions to clean surfaces.

2. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by acid etching, grinding, sanding or abrasive blasting. Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.
3. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
4. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F 710 to ensure pH is between 7 & 8.

C. Scoring: Score decorative jointing in paving surfaces 1/16 inch deep with diamond blades to match pattern indicated. Rinse until water is clear. Score before staining.

1. Joint Width: 3/8 inch.

D. Allow paving surface to dry before applying stain. Verify readiness of paving to receive stain according to ASTM D 4263 by tightly taping 18-by-18-inch thick polyethylene sheet to a representative area of paving surface. Apply stain only if no evidence of moisture has accumulated under sheet after 16 hours.

E. Reactive Stain: Apply reactive stain to paving surfaces according to manufacturer's written instructions and as follows:

1. Apply stain by uncolored bristle brush, roller, or high-volume, low-pressure sprayer and immediately scrub into concrete surface with uncolored, acid-resistant nylon-bristle brushes in continuous, circular motion. Do not spread stain after fizzing stops. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
2. Remove stain residue after four hours by wet scrubbing with commercial-grade detergent recommended by stain manufacturer. Rinse until water is clear. Control, collect, and legally dispose of runoff.

F. Penetrating Stain: Apply to paving surfaces according to manufacturer's written instructions and as follows:

1. Apply first coat of stain to dry, clean surfaces by airless sprayer or by high-volume, low-pressure sprayer.
2. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
3. Rinse until water is clear. Control, collect, and legally dispose of runoff.

## 3.11 SEALER APPLICATION

A. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat, using same application methods and rates.

1. Begin sealing dry surface no sooner than 14 days after concrete placement.
2. Allow stained concrete surfaces to dry before applying sealer.
3. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

## 3.12 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot long, unleveled straightedge not to exceed 1/2 inch.
4. Lateral Alignment and Spacing of Dowels: 1 inch.
5. Vertical Alignment of Dowels: 1/4 inch.
6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
7. Joint Spacing: 3 inches.
8. Contraction Joint Depth: Plus 1/4 inch, no minus.
9. Joint Width: Plus 1/8 inch, no minus.

## 3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals / exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Decorative concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

## 3.14 REPAIR AND PROTECTION

A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

## 3.15 DECORATIVE CONCRETE PAVING SCHEDULE

A. Patterned Decorative Concrete Paving.

1. Locations: Install at locations shown on plan..
2. Coloring Method: Integrally colored or Pigmented mineral dry-shake hardener as an alternative method of construction.
    a. Color: Scofield color “Brownstone”.
3. Field Patterning Method:
    a. Texture and Pattern: Score marks.
    b. Raked striations.

END OF SECTION

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Section includes wheel stops.

### 1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.01 PARKING BUMPERS

A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1800 mm) long]. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Mounting Hardware: Galvanized-steel [spike or dowel, 1/2-inch (13-mm) diameter, 10-inch (254-mm) minimum length] [lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length] [hardware as standard with wheel-stop manufacturer].

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. General: Install wheel stops according to manufacturer's written instructions unless otherwise indicated.

B. Install wheel stops in bed of adhesive before anchoring.

C. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. painted markings applied to asphalt pavement.

### 1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. Aexcel Inc.
2. Benjamin Moore & Co.
3. Color Wheel Paints & Coatings.
4. Columbia Paint & Coatings.
5. Conco Paints.
6. Coronado Paint; Division of INSL-X Products Corporation.
7. Diamond Vogel Paints.
8. Dunn-Edwards Corporation.
9. Ennis Traffic Safety Solutions, Inc.
10. Frazee Paint.
11. General Paint.
12. Kwal Paint.
13. M.A.B. Paints.
14. McCormick Paints.
15. Miller Paint.
16. Parker Paint Mfg. Co. Inc.
17. PPG Industries.
18. Pratt & Lambert.
19. Rodda Paint Co.
20. Rohm and Haas Company; a subsidiary of The Dow Chemical Company.
21. Scott Paint Company.
22. Sherwin-Williams Company (The).

### 2.02 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: MPI #32, alkyd traffic-marking paint.

1. Color: As indicated.

B. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.
   1. Color: As indicated.

C. Glass Beads: AASHTO M 247, Type 1[ made of 100 percent recycled glass].

D. VOC Content: Pavement markings used on building interior shall have a VOC content of 150 g/L or less.

## PART 3 - EXECUTION

### 3.01 GENERAL

A. Perform work in accordance with applicable code(s).

B. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

C. Allow paving to age for a minimum of 30 days before starting pavement marking.

D. Sweep and clean surface to eliminate loose material and dust.

E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
   1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils. Apply paint so that it cannot run beneath the stencil.

F. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal. (0.72 kg/L).

**END OF SECTION**

# 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. Chain-link fences.
2. Chain-link swing gates.
3. Chain-link horizontal cantilever sliding gates.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete"

## 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails and fittings.
b. Chain-link fabric, reinforcements and attachments.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details and attachments to other work.
2. Include accessories, hardware, gate operation and operational clearances.

C. Samples for Verification: For each type of component with factory-applied finish.

D. Delegated-Design Submittal: For structural performance of chain-link fence, gate frameworks and gate including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

## 1.5 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

## 1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.

1. Design Wind Load: 110 mph.

a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed 10 feet for Material Group IA, ASTM F 1043, Schedule 40 steel pipe.

### 2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric: Wire diameter of 0.148 inch.

a. Standard Fabric Mesh Size: 2 inches.
b. No-Climb Fabric Mesh Size: 3/8 inches (where indicated on plan)
c. Polymer-Coated Fabric: ASTM F 668, Class 1 over zinc or Zn-5-Al-MM-alloy-coated steel wire (where indicated on plan)

1) Color: Black, according to ASTM F 934.

d. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Knuckled at both selvages.

### 2.3 CHAIN LINK FENCE FRAMEWORK

A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: As indicated on Drawings.
2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.

a. Line Post: 2.875 inches in diameter unless larger diameter is required to meet delegated design performance requirements.
b. End, Corner, and Pull Posts: 4.0 inches in diameter unless larger diameter is required to meet delegated design performance requirements.

3. Horizontal Framework Members: Intermediate, top and bottom rails according to ASTM F 1043.

a. Top Rail: 1.66 inches in diameter, minimum unless larger diameter is required to meet delegated design performance requirements.

4. Brace Rails: ASTM F 1043.

5. Metallic Coating for Steel Framework:

   a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating according to ASTM A 653/A 653M.

2.4 TENSION WIRE

A. Galvanized Steel Wire: 0.177-inch diameter, tension wire according to ASTM F 1664, Class 1 over zinc or Zn-5-Al-MM-alloy-coated steel wire.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and double swing gate types.

1. Gate Leaf Width: As indicated on the Drawings.
2. Gate Leaf Height: As indicated on the Drawings.
3. Framework Member Sizes & Strength: Based on gate fabric height as indicated on plans.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framework.
2. Gate Posts: Round tubular steel.
3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend as indicated above top of chain-link fabric at both ends of gate frame to attach top vertical picket deterrent assembly.

E. Hardware: Provide hardware for gates as specified in Section 08 71 63 “Detention Door Hardware”. Fence manufacturer shall coordinate hardware with Detention Hardware supplier and make necessary modifications to accommodate hardware specified.

2.6 HORIZONTAL-SLIDE GATES

A. General: ASTM F 1184 for gate posts and single and double sliding gate types.

1. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.

   a. Gate Frame Width and Height: 48 inches wide or less by 72 inches high or less. More than 48 inches wide by 72” high.

B. Pipe and Tubing:

1. Zinc-Coated Steel: Protective coating and finish to match fence framework.
2. Aluminum: ASTM B 429/B 429M; manufacturer's standard finish.
3. Gate Posts: ASTM F 1184. Provide round tubular steel posts.
4. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches as required to attach vertical picket deterrent assemblies.

E. Overhead Track Assembly: Manufacturer's standard track, with overhead framework supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

F. Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from galvanized steel.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Lock: Manufacturer's standard internal device.

2.7 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Hot-Dip Galvanized Steel: 0.106-inch diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

I. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

2.8 GROUT AND ANCHORING CEMENT

A. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure

without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

### 3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line and as shown on plans.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Concealed Concrete: Place top of concrete below grade as indicated on Drawings.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 10 feet o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Intermediate and Bottom Rails: Secure to posts with fittings.

I. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

## 3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

## 3.5 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wood composite fences.

B. Wood composite gates.

C. Excavation for posts.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 06 73 00 - Composite Decking.

1.3 REFERENCES

A. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

B. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C. ASTM D 143 - Standard Test Methods for Small Clear Specimens of Timber.

D. ASTM D 198 - Standard Test Methods of Static Tests of Lumber in Structural Sizes.

E. ASTM D 1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.

F. ASTM D 1413 - Standard Test Method for Wood Preservatives by Laboratory Soil-Block Cultures.

G. ASTM D 1761 - Standard Test Methods for Mechanical Fasteners in Wood.

H. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics.

I. ASTM D 2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.

J. ASTM D 2394 - Standard Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring.

K. ASTM D 2395 - Standard Test Methods for Specific Gravity of Wood and Wood-Based Materials.

L. ASTM D 4761 - Standard Test Methods for Mechanical Properties of Lumber and Wood-Base Structural Material.

M. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

N. ASTM F 1679 - Standard Test Method for Using a Variable Incidence Tribometer (VIT).

O. American Wood Preservers Association (AWPA) E1-06 - Standard Method for Laboratory Evaluation to Determine Resistance to Subterranean Termites.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Design Requirements: Design fence system to withstand Lewis County, WA, 110 MPH steady wind and 130 MPH gusting wind tests.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used indicating sizes, profiles, surface finishes, and performance characteristics, and including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Instructions on care and cleaning of composite wood products.

C. Verification Samples: For each finish product specified, two samples, minimum size 9 inches (229 mm) square, representing actual product, color, and patterns.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

E. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for cleaning and maintenance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle products in accordance w/ the manufacturer's instructions.

B. Store level and flat, off ground or floor, with supports at each end and maximum 24 inches on center.

C. Do not stack wood composite over 8 feet (203 mm) high.

D. Cover wood composite w/ waterproof covering, vented to prevent moisture buildup.

1.7 WARRANTY

A. Provide manufacturer's 25 year residential warranty / 10 year commercial warranty providing coverage against checking, splitting, splintering, rotting, structural damage from termites, and fungal decay of wood composite.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Trex Fencing, which is located at: 160 Exeter Dr.; Winchester, VA 22603; Distributors and Technical Contacts: www.trexfencing.com.

B. Requests for substitutions will be considered in accordance with provisions of Section 01 61 00 – Common Product Requirements.

2.2 MATERIALS

A. Wood composite: Reclaimed wood and plastic with integral coloring; free from toxic chemicals and preservatives:

1. Characteristics:

   a. Abrasion resistance: 0.01 inch wear per 1000 revolutions, tested to ASTM D 2394.
   b. Hardness: 1124 pounds, tested to ASTM D 143.
   c. Self ignition temperature: 743 degrees F, tested to ASTM D 1929.
   d. Flash ignition temperature: 698 degrees F, tested to ASTM D 1929.
   e. Flame spread rating: 80, tested to ASTM E 84.
   f. Water absorption, 24 hour immersion, tested to ASTM D 1037:

      1) Sanded surface: 4.3 percent.
      2) Unsanded surface: 1.7 percent.

   g. Thermal expansion coefficient, 36 inch long samples:

      1) Width: 35.2 x 10-6 to 42.7 x 10-6.
      2) Length: 16.1 x 10-6 to 19.2 x 10-6.

   h. Fastener withdrawal, tested to ASTM D 1761:

      1) Nail: 163 pounds per inch.
      2) Screw: 558 pounds per inch.

   i. Static coefficient of friction:

      1) Dry: 0.53 to 0.55, tested to ASTM D 2047.
      2) Dry: 0.59 to 0.70, tested to ASTM F 1679.
      3) Wet: 0.70 to 0.75, tested to ASTM F 1679.

   j. Fungus resistance, white and brown rot: No decay, tested to ASTM D 1413.
   k. Termite resistance: 9.6 rating, tested to AWPA E-1.
   l. Specific gravity: 0.91 to 0.95, tested to ASTM D 2395.
   m. Compression:

      1) Parallel: 1806 PSI ultimate, 550 PSI design, tested to ASTM D 198.
      2) Perpendicular: 1944 PSI ultimate, 625 PSI design, tested to ASTM D 143.

   n. Tensile strength: 854 PSI ultimate, 250 PSI design, tested to ASTM D 198.
   o. Shear strength: 561 PSI ultimate, 200 PSI design, tested to ASTM D 143.
   p. Modulus of rupture: 1423 PSI ultimate, 250 PSI design, tested to ASTM D 4761.
   q. Modulus of elasticity: 175,000 PSI ultimate, 100,000 PSI design, tested to ASTM D 4761.
   r. Thermal conductivity: 1.57 BTU per inch per hour per square foot at 85 degrees F, tested to ASTM C 177.

## 2.3 COMPONENTS

A. Fence System: Seclusions Privacy Fence System.

   a. Fence height: 4 feet.

   2. Components:

      a. Fence posts.
         1) Post caps: Pyramid.
      b. Top rail
      c. Aluminum bottom rail inserts.
      d. Bottom rail covers/Pickets, 91 inch.
      e. Fence brackets.

3. Surface texture: Smooth
4. Color:
    a. Woodland Brown.

2.4 ACCESSORIES

A. Fasteners: 1-5/8 inch galvanized or corrosion-resistant coated steel. Provide finish nails where applicable.

B. Concrete: Provide as Specified in Section 03 30 00 - Cast-in-Place Concrete; minimum 2500 PSI compressive strength at 28 days, with a 3 to 5 inch slump.

C. Gate Hardware:
1. Provide two Trex hinges per gate leaf minimum, and size to gate weight and conditions.
2. Provide center gate stop and drop rod for double gates.
3. Provide with latching mechanism.
4. Provide with padlock provisions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Cut and drill wood composite using carbide tipped blades.

C. Space posts maximum 8 feet on center.

D. Drill posts to 12 inch diameter. Locate bottom of post 30 inches below grade or below frost line whichever is greater.

E. Place top of concrete 2 inches above finished grade, slope to drain..

F. Screw fence brackets to posts with four 1-5/8 inch long exterior screws.

G. Cut top rails, pickets, bottom rail covers and aluminum bottom rails to lengths required.

H. Slide bottom rail covers over aluminum bottom rail pieces.

I. Position aluminum bottom rail on fence brackets with deeper side of rail channel facing downward.

J. Cut end pickets to height to provide clearance under brackets and screw to posts.

K. Insert pickets into bottom rail, interlocking adjacent pieces.

L. Position top rail and screw attach to top brackets w/ 1-5/8 inch long exterior screws.

M. Use finish nails to secure pickets to rails if the pickets are not tightly interlocked.

N. Place post caps over post tops and secure with construction adhesive or four finish nails.

3.4 CLEANING

A. Clean wood composite to remove stains:

1. Mold, mildew, and berry and leaf stains: Clean surfaces with conventional deck wash containing detergent or sodium hypochlorite.
2. Rust and ground-in dirt: Clean surfaces with cleaner containing oxalic or phosphoric acid.
3. Oil and grease: Clean surfaces with detergent containing degreasing agent.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

# 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. Hydroseeding.
2. Erosion-control material.

B. Related Requirements:

1. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

## 1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawings for specific planting soils.

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

## 1.4 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site with Architect.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's personnel assigned to the Work shall have certification in one of all of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawncare Manager.
    c. Landscape Industry Certified Lawncare Technician.

5. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: March 15 to June 15.
2. Fall Planting: September 1 to October 15.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

## PART 2 - PRODUCTS

### 2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

C. Grass-Seed Mix: Proprietary seed mix as follows:

1. Products: Subject to compliance with requirements, provide the following:

a. “Northwest Playground Seed Mix”

D. Seed Carrier: Inert material, sharp clean sand or perlite.

### 2.2 FERTILIZERS

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

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

### 2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

E. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

## 3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

## 3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

## 3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with non-asphaltic, fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydro-mulching) at a rate of 1000 lbs. / acre.

## 3.6 TURF RENOVATION

A. Renovate existing turf where indicated.

B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor re-grading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

1. Soil Amendment(s): Add soil amendments according to requirements of Section 32 91 13 "Soil Preparation."
2. Initial Fertilizer: Commercial fertilizer applied according to manufacturer's recommendations.

J. Apply seed and protect with straw mulch as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.7 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf

growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

D.

1. Mow perennial ryegrass to a height of 1 to 2 inches.
2. Mow Northwest Playground Seed Mix to a height of 1 to 2 inches.

E. Turf Post-fertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb / 1000 sq. ft. to turf area.

## 3.8 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

## 3.9 PESTICIDE APPLICATION

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

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

## 3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove non-degradable erosion-control measures after grass establishment period.

## 3.11 MAINTENANCE SERVICE

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

1. Seeded Turf: 12 months from date of planting completion.

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants.
2. Landscape edgings.

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

C. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.

D. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site as requested by Owner.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples of each type of mulch.

1.5 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Material shipping / delivery tickets.

C. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.7 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver plants within 36 hours of digging. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

B. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

C. Handle planting stock by root ball.

D. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.9 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
b. Structural failures including plantings falling or blowing over.

2. Warranty Periods: From date of Project Substantial Completion.

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
c. Annuals: Three months.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

C. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball,

but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 21-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Organic Mulch: Fine to medium ground bark chips (hemlock / fir) as indicated on the Drawings.

B. Mineral Mulch: Rounded riverbed gravel or smooth-faced stone.

1. Size Range: 4” minimum to 8” maximum.
2. Color: Light gray color to match boulder color.

2.4 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd.

2.5 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.6 LANDSCAPE EDGINGS

A. Plastic Edging: Standard black polyethylene or vinyl edging, V-lipped bottom, horizontally grooved, extruded in standard lengths, with 9-inch steel angle plastic stakes.

1. Edging Size: 0.1 inch thick by 5 inches deep.

PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil.

B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade. Place manufactured planting soil over exposed subgrade or Blend planting soil in place as indicated on the Drawings.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

B. Backfill Soil: Subsoil and topsoil removed from excavations **may** be used as backfill soil unless otherwise indicated.

3.3 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Backfill: Planting soil, for trees, use backfill as indicated on the Tree Installation Detail.
2. Balled and Burlapped Stock: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Container-Grown Stock: Carefully remove root ball from container without damaging root ball or plant.
4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
5. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
6. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
7. 
    a. Quantity: Two per plant, three for each caliper inch of trees.
8. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.4 TREE, SHRUB, AND VINE PRUNING

A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

B. Do not apply pruning paint to wounds.

3.5 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.6 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 4.0’ dia. around deciduous tree trunk and 6.0’ dia. ring around coniferous tree trunk. Do not place mulch within 6 inches of trunks or stems.
2. Organic Mulch and Mineral Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area and finish level with adjacent finish grades. Do not place mulch within 6 inches of trunks or stems.

3.7 EDGING INSTALLATION

A. Plastic Edging: Install plastic edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 36 inches apart, driven through upper base grooves or V-lip of edging.

B. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4 to 6-inch deep, shovel-cut edge where plastic edging is not shown on the Drawings.

3.8 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

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

E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

## 3.9 MAINTENANCE SERVICE

A. Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period for Trees and Shrubs: 12 months from date of Project Substantial Completion.
2. Maintenance Period for Ground Cover and Other Plants: 12 months from date of project Substantial Completion.

END OF SECTION

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Piping joining materials.

B. Dielectric fittings.

C. Identification devices.

D. Grout.

E. Piping system common requirements.

F. Concrete bases.

### 1.02 REFERENCE STANDARDS

A. Standard Specification for Road, Bridge, and Municipal Construction as amended by City of Chehalis Standards. Hence forth referred to as Standard Specifications.

B. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses 2017.

C. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54- kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2018.

D. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.

E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012, with Editorial Revision (2015).

F. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).

G. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision.

H. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil- Aggregate by Nuclear Methods (Shallow Depth) 2017a.

### 1.03 SUBMITTALS

A. See Section 01 33 00, Submittal Procedures, for submittals.

B. Product Data: For the following:

1. Dielectric fittings.
2. Identification devices.

## PART 2 - PRODUCTS

### 2.01 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Solvent Cements for Joining Plastic Piping:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

## 2.02 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. 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:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Epco Sales, Inc.

d. Hart Industries, International, Inc.

e. Watts Water Technologies, Inc.

f. Zurn Plumbing Products Group; Wilkins Div.

C. Dielectric Flanges:

1. 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:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Epco Sales, Inc.

d. Watts Water Technologies, Inc.

2. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.

a. Pressure Rating 175 psig.

b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Couplings:
1. 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:
a. Calpico, Inc.
b. Lochinvar Corporation.

2. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
a. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
b. End Connections: Threaded.

## 2.03 IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

B. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

C. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.

D. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

E. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

## 2.04 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.01 DIELECTRIC FITTING APPLICATIONS

A. Wet Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 (DN 50) and Smaller: Dielectric couplings or dielectric nipples.
2. NPS 2-1/2 (DN 65) and Larger: Dielectric nipples.

### 3.02 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   a. [PVC] [Steel] Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

### 3.03 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: 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. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.

I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. 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. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

## 3.04 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. **Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves** and at final connection to each piece of equipment.

3. Install dielectric fittings at connections of dissimilar metal pipes.

## 3.05 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

**3.06 IDENTIFICATION**

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

B. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.

C. Locate pipe markers on exposed piping according to the following:

D. Near each valve and control device.

E. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.

F. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.

G. At manholes and similar access points that permit view of concealed piping.

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

I. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

J. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.

K. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

L. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

**3.07 CONCRETE BASES**

M. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete and reinforcement as specified in Section 033053 Miscellaneous Cast-in-Place Concrete.

**3.08 GROUTING**

N. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

1. Clean surfaces that will come into contact with grout.
2. Provide forms as required for placement of grout.
3. Avoid air entrapment during placement of grout.
4. Place grout, completely filling equipment bases.
5. Place grout on concrete bases and provide smooth bearing surface for equipment.
6. Place grout around anchors.
7. Cure placed grout.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Water pipe for site conveyance lines.

B. Pipe valves.

C. Fire hydrants.

### 1.02 RELATED REQUIREMENTS

A. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

### 1.03 REFERENCE STANDARDS

A. AWWA C502 - Dry-Barrel Fire Hydrants 2018.

B. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service 2015.

C. AWWA C800 - Underground Service Line Valves and Fittings 2014.

D. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution 2016.

E. UL 246 - Hydrants for Fire-Protection Service Current Edition, Including All Revisions.

### 1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

### 1.05 SUBMITTALS

A. See Section 01 33 00, Submittal Procedures, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

### 1.06 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.07 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of City of Chehalis. Including tapping of water mains and backflow prevention.
2. Comply with standards of City of Chehalis for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of City of Chehalis for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:
   1. Comply with NSF 14 for plastic potable-water-service piping.
   2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

### 1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

B. Protect crosslinked polyethylene tubing from direct and indirect UV exposure.

### 1.09 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of water-distribution service without Owner's written permission.

### 1.10 COORDINATION

A. Coordinate connection to water main with utility company.

## PART 2 - PRODUCTS

### 2.01 WATER PIPE

A. Ductile Iron Pipe: AWWA C151/A21.51:
   1. Fittings: Ductile iron, standard thickness.
   2. Joints: AWWA C111/A21.11, Styrene butadiene rubber (SBR) or vulcanized SBR gasket with rods.
   3. Jackets: AWWA C105/A21.5 polyethylene jacket.

B. PE, Service Pipe: ASTM F 714, AWWA C906, Class 200.
   1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

C. Copper Tubing: ASTM B88, Type K, Annealed:
   1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
   2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.

D. PVC Pipe: ASTM D1785 Schedule 40.
   1. Fittings: ASTM D2466, PVC.
   2. Joints: ASTM D2855, solvent weld.

E. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Gaskets: AWWA C111, rubber.

F. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances:
    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:

G. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

## 2.02 JOINING MATERIALS

A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. JOINING MATERIALS
1. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.
2. Brazing Filler Metals: AWS A5.8, BCuP Series.
3. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
4. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

## 2.03 VALVES

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Gate Valves Up To 3 Inches (75 mm):
1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.

C. Gate Valves 3 Inches (75 mm) and Over:
1. Shall be resilient wedge with O-ring seals.
2. Valve ends shall be mechanical join by ANSI flanges.
3. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, post indicator, valve key, and extension box.
4. Manufacturers:
    a. Mueller
    b. M&H
    c. Kennedy
    d. Clow R/W
    e. Waterous series 500

D. Ball Valves Up To 2 Inches (50 mm):
1. Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, compression outlet with electrical ground connector, with control rod, valve key, and extension box.

## 2.04 DOUBLE CHECK VALVE AND FIRE DEPARTMENT CONNECTION

A. All materials shall meet the comply of City of Chehalis standards.
1. See City standard drawing 4-6

## 2.05 HYDRANTS

A. Hydrants: shall be Mueller Centurion A423, M&H Reliant style 929, Clow Medallion, or Kennedy Guardian K81D.

B. Hydrant Extensions: Fabricate in multiples of 6 inches (150 mm) with rod and coupling to increase barrel length.

C. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles , one pumper nozzle.

D. Pressure Rating: According to utility company.

E. Finish: Primer and two coats of enamel in sunburst yellow high-grade enamel after installation.

## 2.06 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Elkhart Brass Mfg. Co., Inc.
   2. Fire End & Croker Corporation.
   3. Guardian Fire Equipment, Inc.
   4. Kidde Fire Fighting.
   5. Potter Roemer.
   6. Reliable Automatic Sprinkler Co., Inc.

B. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
   1. Standard: UL 405.
   2. Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 4 (DN 100) outlet.
   3. Inlet Alignment: Square.
   4. Finish Including Sleeve: Polished bronze.

## 2.07 YARD HYDRANT-

A. Description lead-free, non-freeze yard hydrant Woodford model Y1 or approved equal. Hydrant with cast iron head and lift handle with lock option, galvanized steel pipe, bronze and stainless-steel interior components, 1-inch inlet connection with tapped drainage port on housing, and a removable 3/4” male hose connection.

## 2.08 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 31 20 00.

B. Cover: 30 inches min.

## 2.09 ACCESSORIES

A. Valve Boxes: All valves will have a standard Olympic Foundry 910 or 940 water valve box as determined by the water division of City of Chehalis.
   1. If the city approves or requires the use of an Olympic 910 valve box, it will be set to grade with a six-inch ASTM 3034 SDR 35 PVC riser from valve to approximately six inches from the valve box top. If valves are not set in a paved area, a three-by-three-foot concrete pad four inches thick will be set around each valve box at finished grade.
   2. An Olympic Foundry 940 valve box will be required for all locations of heavy traffic. In areas where the valve box is on the shoulder of the road, the ditch and shoulder will be

graded before placing an asphalt or concrete pad. Valve box lids will be ductile iron, anti-kickout, and marked “WATER” (see Standard City Drawing 4-12).

3. All valve locations will be marked on the face of the adjacent curb with a “WV” embossed one-fourth inch into the concrete.
4. Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

B. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

C. Concrete for Thrust Restraints: Concrete type per City of Chehalis standards.

D. Backflow Preventer: Meeting City of Chehalis standards.

E. Meter: Meeting City of Chehalis Standards

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

### 3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

### 3.03 EARTHWORK

A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

### 3.04 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

D. Underground water-service piping NPS 3/4 to NPS 1.5 shall be soft copper tube, [ASTM B 88, Type K (ASTM B 88M), solder-joint fittings, and brazed joints.

E. Underground water-service piping NPS 2 to NPS the following:

1. PE, Service Pipe: ASTM F 714, AWWA C906, Class 200.

### 3.05 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, [metal] [resilient] [high-pressure, resilient]-seated gate valves with valve box.

C. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.

### 3.06 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

### 3.07 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements City of Chehalis and of size and in location indicated.

### 3.08 MAKE CONNECTIONS LARGER THAN NPS 2 (DN 50) WITH TAPPING MACHINE ACCORDING TO THE FOLLOWING:

A. Install tapping sleeve and tapping valve according to MSS SP-60.

B. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.

C. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.

D. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

E. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:

F. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by City of Chehalis.

G. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.

H. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.

I. Install corporation valves into service-saddle assemblies.

J. Install curb valve in water-service piping with head pointing up and with service box.

K. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

### 3.09 JOINT CONSTRUCTION

A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

C. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

D. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

E. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.

F. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.

G. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

### 3.10 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   3. Set-screw mechanical retainer glands.
   4. Bolted flanged joints.
   5. Heat-fused joints.
   6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

C. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

D. Fire-Service-Main Piping: According to NFPA 24.

### 3.11 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

C. MSS Valves: Install as component of connected piping system.

D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

E. WATER METER INSTALLATION

F. Install water meters, piping, and specialties according to utility company's written instructions.

### 3.12 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install bypass piping around backflow preventers.

### 3.13 WATER METER BOX INSTALLATION

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top 2 inches (50 mm) above surface.

### 3.14 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

### 3.15 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

## 3.16 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install protective pipe bollards on two sides of each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

## 3.17 CONNECTIONS

A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to existing water main. Use [tapping sleeve and tapping valve in accordance with City of Chehalis standards.

C. Connect water-distribution piping to interior domestic water, irrigation and fire-suppression piping.

## 3.18 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

## 3.19 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

## 3.20 CLEANING

A. Clean and disinfect water-distribution piping as follows:

B. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

C. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

D. Prepare reports of purging and disinfecting activities.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to municipal sewers.

C. Cleanout access.

### 1.02 RELATED REQUIREMENTS

A. Section 03 30 53 - Cast-In-Place Concrete: Concrete for cleanout base pad construction.

B. Section 31 20 00 - Excavation: Excavating of trenches.

C. Section 31 20 00 - Trenching: Excavating, bedding, and backfilling.

D. Section 31 20 00 - Fill: Bedding and backfilling.

### 1.03 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

### 1.04 REFERENCE STANDARDS

A. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2021.

B. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2020.

C. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping 2001 (Reapproved 2014).

D. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2017.

E. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2016.

F. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material 2014.

### 1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of City of Chehalis with size, location and installation of service utilities.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

### 1.06 SUBMITTALS

A. See Section 01 33 00, Submittal Procedures, for submittals.

B. Product Data: Provide data indicating pipe, pipe accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

E. Field Quality Control Submittals: Document results of field quality control testing.

F. Project Record Documents:
   1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.

## PART 2 - PRODUCTS

### 2.01 SEWER PIPE MATERIALS

A. Provide products that comply with applicable code(s).

B. Plastic Pipe: ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4 to 12 inches, bell and spigot style solvent sealed joint end.

C. Joint Seals: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

D. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

### 2.02 PIPE ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.

B. Casing Spacer: Polyethylene spacer designed to maintain pipe casing integrity.
   1. Manufacturers:
      a. Advance Products & Systems, LLC: www.apsonline.com/#sle.

### 2.03 CLEANOUT MANHOLE

A. Lid and Frame: Cast iron construction.
   1. Lid Design: Open checkerboard grille.
   2. Nominal Lid and Frame Size: 26 inches (660 mm).

B. Acceptable Products:

C. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches (300 mm); nominal shaft diameter of 36 inches (900 mm).

D. Acceptable Products:

E. Base Pad: Cast-in-place concrete of type specified in Section 03 30 00, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

### 2.04 BEDDING AND COVER MATERIALS

A. Pipe Bedding Material: As specified in Section 31 20 00.

B. Pipe Cover Material: As specified in Section 31 20 00.

## PART 3 - EXECUTION

### 3.01 GENERAL

A. Perform work in accordance with applicable code(s).

### 3.02 TRENCHING

A. See Section 31 20 00 for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

### 3.03 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

1. Plastic Pipe: Also comply with ASTM D2321.

C. Lay pipe to slope gradients noted on layout drawings.

D. Connect to building sanitary sewer outlet and municipal sewer system.

E. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 20 00.

### 3.04 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

### 3.05 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with City of Chehalis requirements.

### 3.06 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Pipe and fittings.

B. Manholes.

C. Cleanouts.

D. Nonpressure transition couplings.

E. Catch basins.

### 1.02 REFERENCE STANDARDS

A. Standard Specification for Road, Bridge, and Municipal Construction as amended by City of Chehalis Standards. Hence forth referred to as Standard Specifications.

B. ASTM A 716 - Standard Specification for Ductile Iron Culvert Pipe.

C. ASTM D 3034 SDR 35 - Gasketed Integral Bell PVC Pipe.

D. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

E. ASTM F 679 - Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings Active Standard

F. ASTM F 794 - Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

G. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses 2017.

H. AASHTO M252 TYPE S - Standard Specification for Corrugated Polyethylene Drainage Pipe

I. AASHTO M294 TYPE S - Standard Specification for Corrugated Polyethylene Pipe 12- to 60-in.

J. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2018.

K. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

L. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water This standard covers 3-in. through 64-in.

M. AWWA C153 - .Ductile-Iron Compact Fittings

### 1.03 SUBMITTALS

A. See Section 01 33 00, Submittal Procedures, for submittals.

B. Product Data: For each type of product indicated.

C. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.

2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

### 1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

### 1.05 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than [two] <Insert number> days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Architect's written permission.

## PART 2 - EXECUTION

### 2.01 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

B. Pipe: ASTM A 716, for push-on joints.

C. Standard Fittings: AWWA C151, ductile or gray iron, for push-on joints.

D. Compact Fittings: AWWA C153, for push-on joints.

E. Gaskets: AWWA C111, rubber.

### 2.02 PE PIPE AND FITTINGS

A. Smooth Interior pipe conforming to AASHTO M252 types or AASHTO M294 type S.

B. Gasketed Bell and Spigot Joints

### 2.03 PVC PIPE AND FITTINGS

A. PVC Conforming to ASTM D 3034 SDR 35 or ASTM F 794 or ASTM F 679 type 1

B. Joints and Gaskets conforming to ASTM 3212 and ASTM F 477.

### 2.04 CONCRETE PIPE AND FITTINGS

A. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM M 86 SCLASS 2.

B. Reinforced-Concrete Sewer Pipe and Fittings: AASHTO M 170

### 2.05 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

## 2.06 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty, and Extra-Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

## 2.07 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder] [Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

2. Material: [ASTM A 536, Grade 60-40-18 ductile] [ASTM A 48/A 48M, Class 35 gray] iron unless otherwise indicated.

## 2.08 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

3. Riser Sections: 4-inch (102-mm) minimum thickness, 48-inch (1200-mm) diameter, and lengths to provide depth indicated.

4. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.

5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

6. Grade Rings: Include two or three reinforced-concrete rings of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.

7. Steps: Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [60 inches (1500 mm)] <Insert dimension>.

8. 9. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches (610 by 610 mm) minimum unless otherwise indicated.

2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

## 2.09 BAYFILTER

A. A. Internal components: all components including concrete structure(s), PVC manifold piping and filter cartridges, shall be provided by BaySaver Technologies, 1030 Deer Hollow Drive, Mount Airy, MD (1.800.229.7283).

B. PVC manifold piping: all internal PVC pipe and fittings shall meet ASTM D1785. Manifold piping shall be provided to the contractor partially pre-cut and pre-assembled.

C. Filter cartridges: external shell of the filter cartridges shall be substantially constructed of polyethylene or equivalent material acceptable to the manufacturer. Filtration media shall be arranged in a spiral layered fashion to maximize available filtration area. An orifice plate shall be supplied with each cartridge to restrict the low rate to a maximum of 45 gpm.

D. Filter media: filter media shall be by BaySaver Technologies and shall consist of the following mix: a blend of zeolite, perlite and activated alumina.

E. Precast concrete vault: concrete structures shall be provided according to ASTM C. The materials and structural design of the devices shall be per ASTM C478, C857 and C858. Precast concrete shall be provided by BaySaver Technologies.

### 2.10 FILL MATERIALS

A. General Fill Complying with City of Chehalis Public Works

B. General: **Provide imported borrow soil materials**. Native soils are expected to be Unsatisfactory soils.

C. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

D. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups. 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

E. Bedding material shall conform to section 9-03.16 of standard specification for road, bridge, and municipal construction as amended by City of Chehalis Standards.

F. Bank run gravel for trench backfill shall conform to 9-03.19 Bank Run Gravel for Trench Backfill of standard specification for road, bridge, and municipal construction as amended by City of Chehalis Standards

### 2.11 SOURCE QUALITY CONTROL

A. Provide materials of each type from same source throughout the Work.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Verify that survey benchmarks and intended elevations for the work are as indicated.

### 3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate existing utilities that remain from damage.

C. Protect benchmarks; survey control points; existing structures; fences; sidewalks, and curbs from excavating equipment and vehicular traffic.

D. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Architect.

### 3.03 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### 3.04 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

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.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
3. Install PE corrugated sewer piping according to ASTM D 2321.
4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
6. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

## 3.05 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

## 3.06 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [3 inches (76 mm)] <Insert dimension> above finished surface elsewhere unless otherwise indicated.

## 3.07 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

## 3.08 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

## 3.09 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

B. Use detectable warning tape over ferrous piping.

C. Use detectable warning tape over nonferrous piping and over edges of underground structures.

## 3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. 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. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction.:

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

**END OF SECTION**

INSIGHT GEOLOGIC, INC.

March 17, 2021

KMB Architects
906 Columbia Street SW, Suite 400
Olympia, Washington 98501
Attention: Michelle Ha

Report
Geotechnical Investigation
Lewis County Juvenile Court Expansion
Chehalis, Washington
Project No. 913-004-01

## INTRODUCTION

Insight Geologic is pleased to provide our report of geotechnical engineering services to evaluate subsurface conditions as they relate to geotechnical parameters for the proposed Lewis County Juvenile Court expansion in Chehalis, Washington. The approximate location of the site is shown relative to surrounding physical features in the Vicinity Map, Figure 1. We understand that the expansion will include a single-story extension of the building for court facilities. Additional parking will be constructed to the west of the building. We have reviewed the information provided by KMB Architects and RB Engineering regarding the proposed site plans.

## SCOPE OF SERVICES

The purpose of our services was to provide a geotechnical assessment of the site and provide recommendations for foundation support and repair. The specific scope of services performed for this project included:

1. Conducted a site visit prior to subsurface exploration to coordinate and mark exploration locations.
2. Coordinated the location of existing underground utilities in the project area. We contacted the Washington Utilities Coordinating Council “One Call” services to conduct this task.
3. Explored the subsurface soil conditions on the site by drilling four (4) borings using a truck-mounted drill rig subcontracted to Insight Geologic and one (1) boring using a manual hand auger. The borings were drilled to depths of between 6.5 and 32 feet below the ground surface (bgs). Soils encountered during the drilling were classified in general accordance with ASTM D1445 Methodology Soil cuttings produced from the borings were placed into drums and removed from the site.

4. Collected representative soil samples from the borings, as needed, for laboratory analyses which included grain-size distribution to assist with geotechnical recommendations.
5. Prepared a report that includes a summary of our field activities, our findings, and recommendations for site preparation and grading, bearing capacity, temporary and final cut slopes, earth pressures, seismic class, seismic settlement, and suitability of the on-site soils for use as fill.

## SITE CONDITIONS

### Surface Conditions

The project site consists of the Lewis County Juvenile Court building and immediate environs totaling approximately 2 acres in the southeast corner of the larger Green Hill School Facility parcel. The site is situated at an elevation of approximately 190 feet above mean sea level. The project area is roughly rectangular in shape and bounded by SW Parkland Drive to the southeast, SW Pacific Avenue to the northeast, the Green Hill School Facility to the northwest, and a stormwater drainage pond to the southwest. The project site is generally flat and mostly paved or landscaped with the Lewis County Juvenile Court building centrally located on the site.

### Geology

Based on our review of available published geologic maps, Pleistocene-age alpine glacial outwash deposits (river terrace and flood plain deposits) of the Hayden Creek Drift underlie the project site. Quaternary alluvium is mapped to the south of the site. The drift material is described as poorly-sorted sands and gravels with units of silt, and varying fractions of organic material and with the upper portions generally being heavily weathered. Soils in this area are known to have the potential for being soft and having moderate plasticity.

### Subsurface Explorations

We explored subsurface conditions at the site on February 22 and 26, 2021 by advancing five borings in the locations as shown on the Site Plan, Figure 2. Borings B-1 and B-2 were drilled within the existing parking lot on the east side of the building and in the area of the proposed addition. Borings B-3 and B-4 were drilled on the south side of the building in the area of the proposed new parking lot, and boring B-5 was drilled on the west side of the building in an area designated for facility vehicle parking. Borings B-1 to B-4 were completed with a truck-mounted drilling rig fitted with hollow-stem augers. Soil samples were collected at 5-foot intervals during drilling. Boring B-5 was completed using a manually advanced hand auger and soil samples were collected in 1-foot increments. Our exploration depths ranged from 3 to 32 feet bgs. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The soils were visually classified in general accordance with the system described in ASTM D2487-06. The exploration logs are contained in Attachment A.

### Soil Conditions

Soil conditions encountered were generally consistent across the site. Underlying approximately 6 inches of asphalt and surfacing rock or sod, we encountered up to 6 feet of silt (ML) in a moist and medium-stiff condition, overlying brown to orange-brown silty sand with gravel (SM) in a moist to wet

and medium dense to very dense condition. In general, soils were encountered in a dense to very dense condition at a depth of 15 feet bgs.

### Groundwater Conditions

Groundwater was encountered at depths of 18 and 15 feet bgs in borings B-1 and B-2, respectively. Groundwater was not encountered in the remainder of the borings, having been completed at shallower depths.

### Laboratory Testing

We selected eleven soil samples for gradation analyses in general accordance with ASTM D422 to define soil class and assist with geotechnical recommendations. Our laboratory test results are provided in Attachment B.

## SEISMIC DESIGN CONSIDERATIONS

### General

We understand that seismic design will likely be performed using the 2018 IBC standards. The following parameters may be used in computing seismic base shear forces:

**Table 1. 2018 IBC Seismic Design Parameters**

| |
|---|
| Spectral Response Accel. at Short Periods (SS) = 1.168 |
| Spectral Response Accel. at 1 Second Periods (S1) = 0.482 |
| Site Class = D |
| Site Coefficient (FA) = 1.033 |
| Site Coefficient (FV) = 1.5 |

### Soil Liquefaction

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in the development of excess pore water pressures in saturated soils, and a subsequent loss of stiffness in the soil occurs. Liquefaction also causes a temporary reduction of soil shear strength and bearing capacity, which can cause settlement of the ground surface above the liquefied soil layers. In general, soils that are most susceptible to liquefaction include loose to medium dense, clean to silty sands and non-plastic silts.

Based on our review of the *Washington State Department of Natural Resources Geologic Information Portal*, the majority of the site including the building location is identified to have a very low potential risk for liquefaction. Based on our experience with detailed seismic studies in the area, including areas that are mapped within the same soil deposits as the project site, it is our opinion that the soil profile at the site has a low risk of liquefaction.

### Seismic Compression

Seismic compression is defined as the accrual of contractive volumetric strains in unsaturated soils during strong shaking from earthquakes (Stewart et al., 2004). Loose to medium dense clean sands and non-plastic silts are particularly prone to seismic compression settlement. Seismic compression

settlement is most prevalent on slopes, but it can also occur on flat ground. It is our opinion that the soil profile at the site has a low to moderate risk for settlement due to seismic compression.

### Lateral Spreading

Lateral spreading involves the lateral displacement of surficial blocks of non-liquefied soil when an underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground or large grade changes are present. Based on our limited understanding of the subsurface conditions at the site, it is our opinion that there is a low risk for the development of lateral spreading as a result of an IBC design level earthquake.

## CONCLUSIONS AND RECOMMENDATIONS

### General

Based on the results of our review, subsurface explorations and engineering analyses, it is our opinion that the proposed development is feasible from a geotechnical standpoint. We recommend that the proposed structures be supported on shallow concrete foundations that are designed using an allowable soil bearing capacity of 1,500 pounds per square foot (psf).

The soils encountered in our explorations are typically in a medium-stiff condition near the ground surface. To limit the potential for structure settlement, we recommend that shallow foundations and slabs-on-grade be established on a minimum 1-foot thick layer of structural fill. A soil bearing capacity of 2,000 psf can be used if a layer of geogrid is included below the structural fill section.

### Earthwork

#### *General*

We anticipate that site development earthwork will include stripping surfacing materials, preparing subgrades, excavating for utility trenches, and placing and compacting structural fill. The soils at the site contain a high percentage of fines, are moisture sensitive, and will not be suitable for structural fill. These materials may be difficult to operate on or compact during wet weather. Operation of heavy equipment at the site under wet conditions or when the soils are above optimum moisture content can be expected to result in considerable disturbance to the exposed subgrade soils. We recommend that earthwork be undertaken during periods of dry weather to reduce grading costs. We expect that the majority of site grading can be accomplished with conventional earthmoving equipment in proper working order.

Our explorations did not encounter appreciable amounts of debris or unsuitable soils associated with past site development. Still, it is possible that unsuitable materials could be encountered within the imported fill material during construction. The contractor should be prepared to deal with these conditions.

#### *Clearing and Stripping*

Clearing and stripping should consist of removing surface and subsurface deleterious materials including sod/topsoil, asphalt, debris and other unsuitable loose/soft or organic materials. Stripping and clearing should extend at least 5 feet beyond all structures and areas to receive structural fill.

We estimate that a stripping depth of about 0.5 feet will be required to remove the surfacing rock, asphalt and vegetation encountered in our explorations. Deeper stripping depths may be required if additional unsuitable soils are exposed during stripping operations.

### *Subgrade Preparation*

After stripping and excavating to the proposed subgrade elevation, and before placing structural fill or foundation concrete, the exposed subgrade should be thoroughly compacted to a firm and unyielding condition. The exposed subgrade should then be proof-rolled using loaded, rubber-tired heavy equipment. We recommend that Insight Geologic be retained to observe the proof-rolling prior to placement of structural fill or foundation concrete. Areas of limited access that cannot be proof-rolled can be evaluated using a steel probe rod. If soft or otherwise unsuitable areas are revealed during proof-rolling or probing, that cannot be compacted to a stable and uniformly firm condition, we generally recommend that: 1) the subgrade soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted; or 2) the unsuitable soils be overexcavated and replaced with structural fill.

### *Temporary Excavations and Groundwater Handling*

Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls were required under the Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes should be inclined no steeper than about 1.5H:1V (horizontal: vertical). This guideline assumes that all surface loads are kept at a minimum distance of at least one-half the depth of the cut away from the top of the slope, and that significant seepage is not present on the slope face. Flatter cut slopes were necessary where significant seepage occurs or if large voids are created during excavation. Some sloughing and raveling of cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect slopes during periods of wet weather.

We anticipate that if perched groundwater is encountered during construction, it can be handled adequately with sumps, pumps, and/or diversion ditches. Groundwater handling needs will generally be lower during the late summer and early fall months. We recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered during construction.

### *Permanent Slopes*

We do not anticipate that permanent slopes will be utilized for the proposed project. If permanent slopes are necessary, we recommend the slopes be constructed at a maximum inclination of 2H:1V. Where 2H:1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered.

To achieve uniform compaction, we recommend that fill slopes be overbuilt and subsequently cut back to expose well-compacted fill. Fill placement on slopes should be benched into the slope face and include keyways. The configuration of the bench and keyway depends on the equipment being used. Bench excavations should be level and extend into the slope face. We recommend that a vertical cut of about 3 feet be maintained for benched excavations. Keyways should be about 1-1/2 times the width of the equipment used for grading or compaction.

### *Erosion Control*

We anticipate that erosion control measures such as silt fences, straw bales and sandbags will generally be adequate during development. Temporary erosion control should be provided during construction activities and until permanent erosion control measures are functional. Surface water runoff should be properly contained and channeled using drainage ditches, berms, swales, and tightlines, and should not discharge onto sloped areas. Any disturbed sloped areas should be protected with a temporary covering until new vegetation can take effect. Jute or coconut fiber matting, excelsior matting or clear plastic sheeting is suitable for this purpose. Graded or disturbed slopes should be tracked in-place with the equipment running perpendicular to the slope contours so that the track marks provide a texture to help resist erosion. Ultimately, erosion control measures should be in accordance with local regulations and should be clearly described on project plans.

### *Wet Weather Earthwork*

The near-surface soils contain a significant amount of fines. When the moisture content of the soil is more than a few percent above the optimum moisture content, the soil will become unstable and it will be difficult or impossible to meet the required compaction criteria. Disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather.

The wet weather season in this area generally begins in October and continues through May. However, periods of wet weather may occur during any month of the year. If wet weather earthwork is unavoidable, we recommend that:

- The ground surface is sloped so that surface water is collected and directed away from the work area to an approved collection/dispersion point.
- Earthwork activities not take place during periods of heavy precipitation.
- Slopes with exposed soil are covered with plastic sheeting or otherwise protected from erosion.
- Measures are taken to prevent on-site soil and soil stockpiles from becoming wet or unstable. Sealing the surficial soil by rolling with a smooth-drum roller prior to periods of precipitation should reduce the extent that the soil becomes wet or unstable.
- Construction traffic is restricted to specific areas of the site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- A minimum 1-foot thick layer of 4- to 6-inch quarry spalls is used in high traffic areas of the site to protect the subgrade soil from disturbance.
- Contingencies are included in the project schedule and budget to allow for the above elements.

## Structural Fill Materials

### *General*

Material used for structural fill should be free of debris, organic material and rock fragments larger than 3 inches in diameter. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve.

### *On-Site Soil*

We anticipate that the majority of the on-site soils encountered during construction will consist of silt with a high moisture content. It is our opinion that this material is not a suitable source for structural fill during a significant portion of the year. It will likely be difficult or impossible to compact this material without significant effort to reduce the moisture content. It is our recommendation that the silts encountered during excavation and grading should be wasted and hauled offsite, and not used for structural fill. All soils used as fill shall be select granular fill as described as follows.

### *Select Granular Fill*

Select granular fill should consist of imported, well-graded sand and gravel or crushed rock with a maximum particle size of 3 inches and less than 5 percent passing a U.S. Standard No. 200 sieve based on the minus ¾-inch fraction. Organic matter, debris or other deleterious material should not be present. In our experience, “gravel borrow” as described in Section 9-03.14(1) of the 2020 WSDOT Standard Specifications is typically a suitable source for select granular fill during periods of wet weather, provided that the percent passing a U.S. Standard No. 200 sieve is less than 5 percent based on the minus ¾-inch fraction.

## Structural Fill Placement and Compaction

### *General*

Structural fill should be placed on an approved subgrade that consists of uniformly firm and unyielding inorganic native soils or compacted structural fill. Structural fill should be compacted at a moisture content near optimum. The optimum moisture content varies with the soil gradation and should be evaluated during construction.

Structural fill should be placed in uniform, horizontal lifts and uniformly densified with vibratory compaction equipment. The maximum lift thickness will vary depending on the material and compaction equipment used but should generally not exceed the loose thicknesses provided in Table 2. Structural fill materials should be compacted in accordance with the compaction criteria provided in Table 3.

**Table 2. Recommended Uncompacted Lift Thickness**

| Compaction Equipment | Recommended Uncompacted Fill Thickness (inches) | |
|---|---|---|
| | Granular Materials Maximum Particle Size ≤ 1 1/2 inch | Granular Materials Maximum Particle Size > 1 1/2 inch |
| Hand Tools (Plate Compactors and Jumping Jacks) | 4 – 8 | Not Recommended |
| Rubber-tire Equipment | 10 – 12 | 6 – 8 |
| Light Roller | 10 – 12 | 8 – 10 |
| Heavy Roller | 12 – 18 | 12 – 16 |
| Hoe Pack Equipment | 18 – 24 | 12 – 16 |

Note: The above table is intended to serve as a guideline and should not be included in the project specifications.

**Table 3. Recommended Compaction Criteria in Structural Fill Zones**

| Fill Type | Percent Maximum Dry Density Determined by ASTM Test Method D 1557 at ±3% of Optimum Moisture | | |
|---|---|---|---|
| | 0 to 2 Feet Below Subgrade | > 2 Feet Below Subgrade | Pipe Zone |
| Imported or On-site Granular, Maximum Particle Size < 1-1/4-inch | 95 | 95 | ----- |
| Imported or On-site Granular, Maximum Particle Size >1-1/4-inch | N/A (Proof-roll) | N/A (Proof-roll) | ----- |
| Trench Backfill[1] | 95 | 92 | 90 |

Note: [1]Trench backfill above the pipe zone in nonstructural areas should be compacted to at least 85 percent.

## Shallow Foundation Support

### *General*

We recommend that proposed structures be founded on continuous wall or isolated column footings, bearing on a minimum 1-foot thick overexcavation and replacement with compacted structural fill. The structural fill zone should extend to a horizontal distance equal to the overexcavation depth on each side of the footing. The actual overexcavation depth will vary, depending on the conditions encountered.

We recommend that an experienced geotechnical owner-representative observe the foundation surfaces before overexcavation, and before placing structural fill in overexcavations. This representative should confirm that adequate bearing surfaces have been prepared and that the soil conditions are as anticipated. Unsuitable foundation bearing soils should be recompacted or removed and replaced with compacted structural fill, as recommended by the geotechnical engineer.

### *Bearing Capacity and Footing Dimensions*

We recommend an allowable soil bearing pressure of 1,500 psf for shallow foundations that are supported on a 1-foot thick section of compacted structural fill. This allowable bearing pressure

applies to long-term dead and live loads exclusive of the weight of the footing and any overlying backfill. The allowable soil bearing pressure can be increased by one-third when considering total loads, including transient loads such as those induced by wind and seismic forces.

We recommend a minimum width of 18 inches for continuous wall footings and 2 feet for isolated column footings, unless otherwise designed by a structural engineer. For settlement considerations, we have assumed a maximum width of 4 feet for continuous wall footings and 6 feet for isolated column footings.

Perimeter footings should be embedded at least 12 inches below the lowest adjacent grade where the ground is flat to protect against frost. Interior footings should be embedded a minimum of 6 inches below the nearest adjacent grade.

### *Settlement*

We estimate that the total settlement of footings that are designed and constructed as recommended should be less than 1 inch. We estimate that differential settlement should be ½ inch or less between comparably loaded isolated footings or along 50 feet of continuous footing. We anticipate that the settlement will occur essentially as loads are applied during construction.

### *Subsurface Drainage*

It is our opinion that foundation footing drains are likely necessary for any proposed structure. The near-surface site soils consist of silt and are generally poorly draining. Footing drains should be routed to existing on-site or planned storm drainage.

### *Lateral Load Resistance*

Lateral loads on shallow foundation elements may be resisted by passive resistance on the sides of footings and by friction on the base of footings. Passive resistance (Kp) may be estimated using an equivalent fluid density of 159 pounds per cubic foot (pcf), assuming that the footings are backfilled with structural fill. Active earth pressure (Ka) for the soil is 55 pcf as equivalent fluid density. Frictional resistance may be estimated using 0.20 for the coefficient of base friction.

The lateral resistance values provided above incorporate a factor of safety of 1.5. The passive earth pressure and friction components can be combined, provided that the passive component does not exceed two-thirds of the total. The top foot of soil should be neglected when calculating passive resistance, unless the foundation perimeter area is covered by a slab-on-grade or pavement.

## Slabs-On-Grade

Slabs-on-grade should be established on a minimum 1-foot thick section of structural fill extending to an approved bearing surface. A modulus of vertical subgrade reaction (subgrade modulus) can be used to design slabs-on-grade. The subgrade modulus varies based on the dimensions of the slab and the magnitude of applied loads on the slab surface; slabs with larger dimensions and loads are influenced by soils to a greater depth. We recommend a modulus value of 100 pounds per cubic inch (pci) for design of on-grade floor slabs with floor loads up to 500 psf. We are available to provide alternate subgrade modulus recommendations during design, based on specific loading information.

We recommend that slabs-on-grade in interior spaces be underlain by a minimum 4-inch thick capillary break layer to reduce the potential for moisture migration into the slab. The capillary break material should consist of well-graded sand and gravel or crushed rock containing less than 5 percent fines based on the fraction passing the ¾-inch sieve. The 4-inch thick capillary break layer can be included when calculating the minimum 1-foot thick structural fill section beneath the slab. If dry slabs are required (e.g., where adhesives are used to anchor carpet or tile to the slab), a waterproofing liner should be placed below the slab to act as a vapor barrier.

## Conventional Retaining Walls

### *General*

The following sections provide general guidelines for retaining wall design on this site. Since the site is fairly level, we do not anticipate that retaining walls will be necessary. However, we should be contacted during the design phase to review retaining wall plans and provide supplemental recommendations, if needed.

### *Drainage*

Positive drainage is imperative behind any retaining structure. This can be accomplished by using a zone of free-draining material behind the wall with perforated pipes to collect water seepage. The drainage material should consist of coarse sand and gravel containing less than 5 percent fines based on the fraction of material passing the ¾-inch sieve. The wall drainage zone should extend horizontally at least 12 inches from the back of the wall. If a stacked block wall is constructed, we recommend that a barrier such as a non-woven geotextile filter fabric be placed against the back of the wall to prevent loss of the drainage material through the wall joints.

A perforated smooth-walled rigid PVC pipe, having a minimum diameter of 4 inches, should be placed at the bottom of the drainage zone along the entire length of the wall. Drainpipes should discharge to a tightline leading to an appropriate collection and disposal system. An adequate number of cleanouts should be incorporated into the design of the drains in order to provide access for regular maintenance. Roof downspouts, perimeter drains or other types of drainage systems should not be connected to retaining wall drain systems.

### *Design Parameters*

We recommend an active lateral earth pressure of 34 pcf for a level backfill condition. This assumes that the top of the wall is not structurally restrained and is free to rotate. For restrained walls that are fixed against rotation (at-rest condition), an equivalent fluid density of 55 pcf can be used for the level backfill condition. For seismic conditions, we recommend a uniform lateral pressure of 14H psf (where H is the height of the wall) be added to the lateral pressures. This seismic pressure assumes a peak ground acceleration of 0.32 g. Note that if the retaining system is designed as a braced system but is expected to yield a small amount during a seismic event, the active earth pressure condition may be assumed and combined with the seismic surcharge.

The recommended earth pressure values do not include the effects of surcharges from surface loads or structures. If vehicles will be operated within one-half the height of the wall, a traffic surcharge should be added to the wall pressure. The traffic surcharge can be approximated by the equivalent

weight of an additional 2 feet of backfill behind the wall. Other surcharge loads, such as construction equipment, staging areas and stockpiled fill, should be considered on a case-by-case basis.

### Pavement

We anticipate that the subgrade for the new parking areas will consist of the native silty soils. We recommend that subgrades be proofrolled using a loaded dump truck prior to placing any granular subbase, asphalt concrete base or crushed rock base course. Soft, loose or otherwise unsuitable zones identified during proofrolling should be removed and replaced with compacted structural fill. We recommend that a qualified professional observe the proofrolling of roadway subgrade areas and the repair of unsuitable zones.

The typical design pavement section for areas exposed to automobile traffic only consists of 2 inches of Hot Mix Asphalt (HMA) Class ½-inch, PG 64-22 (Class B equivalent) over 6 inches of compacted crushed rock base course. In areas of truck traffic, such as driveways, pavement sections should consist of at least 3 inches Hot Mix Asphalt (HMA) Class ½-inch, PG 64-22 (Class B equivalent) over at least 10 inches of base course. The crushed surfacing base course should meet the requirements of Section 9-03.9(3) of the 2004 WSDOT Standard Specifications.

The crushed surfacing base course should be compacted to at least 95 percent of the maximum dry density prior to the placement of the asphalt concrete. We recommend that proofrolling of the compacted base course be observed by a qualified professional prior to paving. Soft or yielding areas observed during proofrolling may require excavation and replacement with compacted structural fill.

All new pavement materials and compaction should conform to the WSDOT 2020 Standard Specifications. The sand and gravel subbase should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D-1557 test procedure.

## DOCUMENT REVIEW AND CONSTRUCTION OBSERVATION

We recommend that we be retained to review the portions of the plans and specifications that pertain to earthwork construction. We recommend that monitoring, testing and consultation be performed during construction to confirm that the conditions encountered are consistent with our explorations and our stated design assumptions. Insight Geologic would be pleased to provide these services upon request.

## LIMITATIONS

We have prepared this geotechnical investigation report for the exclusive use of KMB Architects and their authorized agents, for the proposed Lewis County Juvenile Court expansion located in Chehalis, Washington.

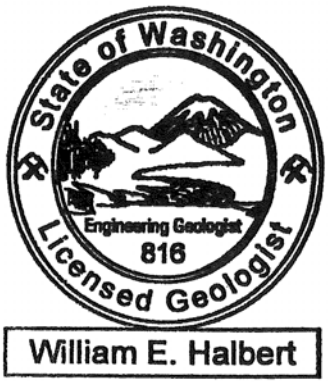
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Attachment C titled “Report Limitations and Guidelines for Use” for additional information pertaining to the use of this report.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have questions or require additional information.

Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

William E. Halbert, L.E.G., L.HG.
Principal




Attachments

# FIGURES




N.T.S.

# LEWIS COUNTY JUVENILE COURT

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map




SOURCE: KMB ARCHITECTS

## LEGEND:

B-1 APPROXIMATE BORING LOCATION

APPROXIMATE PROPERTY BOUNDARY

N.T.S.

# LEWIS COUNTY JUVENILE COURT

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

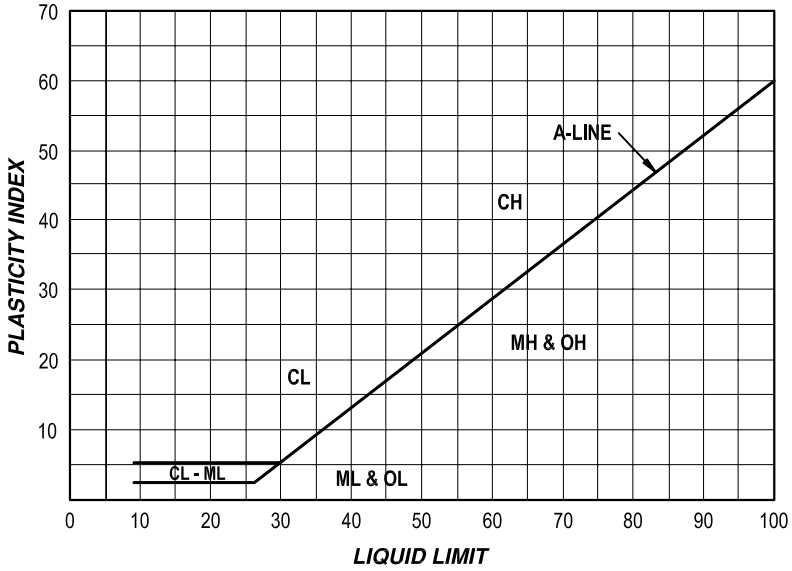
Figure 2

Site Plan

# ATTACHMENT A
# EXPLORATION LOGS

## SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS | | | SYMBOLS | GROUP NAME |
|---|---|---|---|---|
| COARSE GRAINED SOILS (MORE THAN 50% RETAINED ON NO. 200 SIEVE) | GRAVEL AND GRAVELLY SOILS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE) | CLEAN GRAVEL <5% FINES | GW | WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL |
| | | | GP | POORLY GRADED GRAVEL |
| | | GRAVEL WITH FINES >12% FINES | GM | SILTY GRAVEL |
| | | | GC | CLAYEY GRAVEL |
| | SAND AND SANDY SOILS (MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE) | CLEAN SAND <5% FINES | SW | WELL-GRADED SAND, FINE TO COARSE SAND |
| | | | SP | POORLY GRADED SAND |
| | | SAND WITH FINES >12% FINES | SM | SILTY SAND |
| | | | SC | CLAYEY SAND |
| FINE GRAINED SOILS (MORE THAN 50% PASSING NO. 200 SIEVE) | SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50) | INORGANIC | ML | SILT |
| | | | CL | CLAY |
| | | ORGANIC | OL | ORGANIC SILT, ORGANIC CLAY |
| | SILTS AND CLAYS (LIQUID LIMIT 50 OR MORE) | INORGANIC | MH | SILT OF HIGH PLASTICITY, ELASTIC SILT |
| | | | CH | CLAY OF HIGH PLASTICITY, FAT CLAY |
| | | ORGANIC | OH | ORGANIC CLAY, ORGANIC SILT |
| HIGHLY ORGANIC SOILS | | | PT | PEAT |




**SOIL MOISTURE MODIFIERS:**
DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST - DAMP, BUT NO VISIBLE WATER
WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED BELOW WATER TABLE

## ADDITIONAL MATERIAL SYMBOLS

| SYMBOLS | TYPICAL DESCRIPTION |
|---|---|
| CC | CEMENT CONCRETE |
| AC | ASPHALT CONCRETE |
| CR | CRUSHED ROCK / QUARRY SPALLS |
| TS | TOPSOIL/SOD/DUFF |

## GROUNDWATER EXPLORATION SYMBOLS

- MEASURED GROUNDWATER LEVEL IN EXPLORATION, WELL, OR PIEZOMETER
- GROUNDWATER OBSERVED AT TIME OF EXPLORATION
- PERCHED WATER OBSERVED AT TIME OF EXPLORATION
- MEASURED FREE PRODUCT IN WELL OR PIEZOMETER

## STRATIGRAPHIC CONTACT

- APPROXIMATE CONTACT BETWEEN SOIL STRATA OR GEOLOGIC UNIT
- APPROXIMATE LOCATION OF SOIL STRATA CHANGE WITHIN GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE BETWEEN SOIL STRATA OR GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE OF SOIL STRATA WITHIN GEOLOGIC SOIL UNIT

## LABORATORY / FIELD TEST CLASSIFICATIONS

- **%F** PERECENT FINES
- **AL** ATTERBERG LIMITS
- **CA** CHEMICAL ANALYSIS
- **CP** LABORATORY COMPACTION TEST
- **CS** CONSOLIDATION TEST
- **DS** DIRECT SHEAR
- **HA** HYDROMETER ANALYSIS
- **MC** MOISTURE CONTENT
- **MD** MOISTURE CONTENT AND DRY DENSITY
- **OC** ORGANIC COMPOUND
- **PM** PERMEABILITY OR HYDRAULIC CONDUCTIVITY
- **PP** POCKET PENETROMETER
- **SA** SIEVE ANALYSIS
- **TX** TRIAXIAL COMPRESSION
- **UC** UNCONFINED COMPRESSION
- **VS** VANE SHEAR

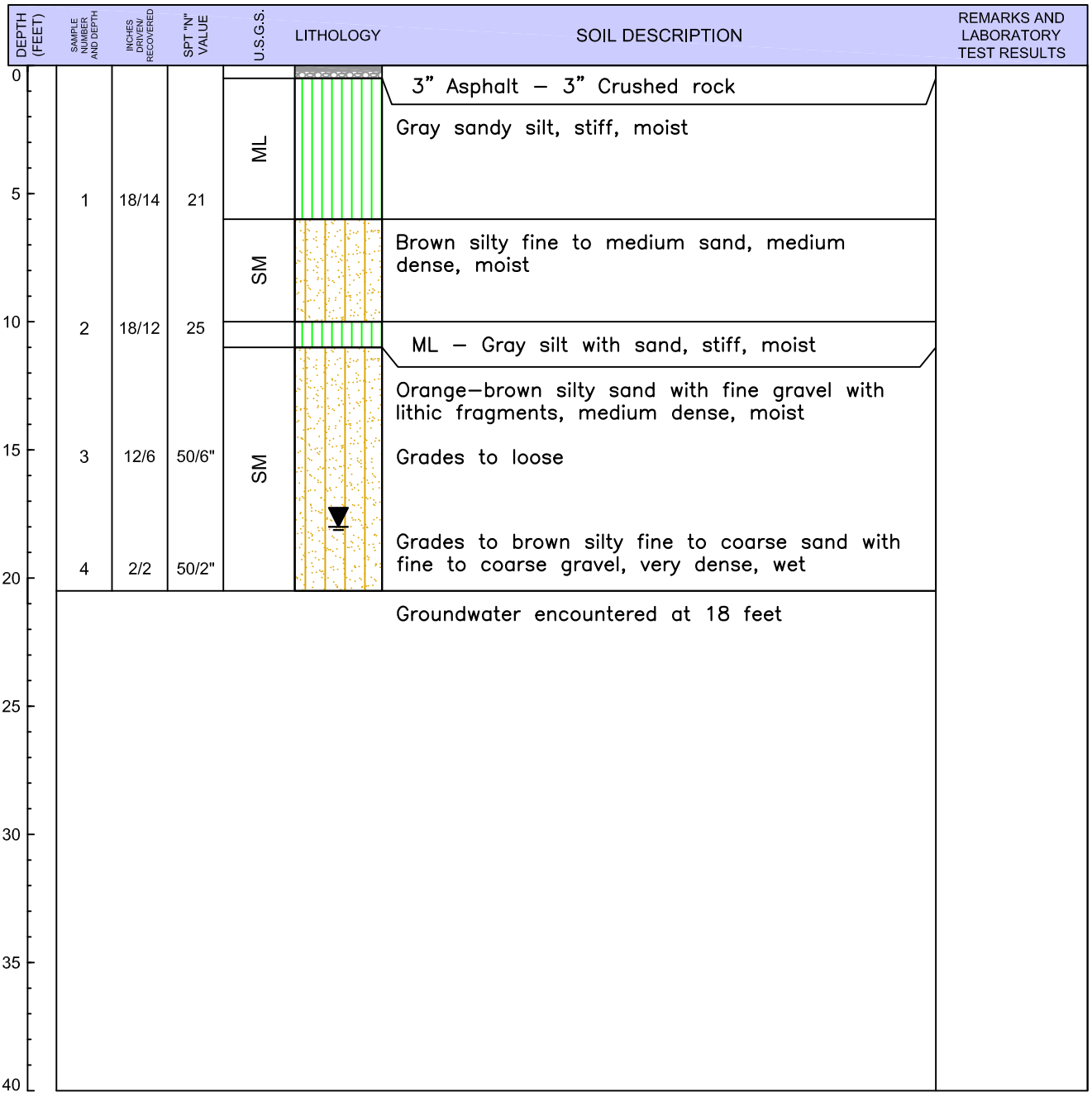
## SAMPLER SYMBOLS

- 2.4 INCH I.D. SPLIT BARREL
- DIRECT-PUSH
- STANDARD PENETRATION TEST
- SHELBY TUBE
- PISTON
- BULK OR GRAB

## SHEEN CLASSIFICATIONS

- **NS** NO VISIBLE SHEEN
- **SS** SLIGHT SHEEN
- **MS** MODERATE SHEEN
- **HS** HEAVY SHEEN
- **NT** NOT TESTED

# B-1




LEGEND:

PROJECT NO.: 913-004-01
DATE: FEBRUARY 22, 2021
TOTAL DEPTH: 20.5 FEET
DRILLING CONTRACTOR: HOLOCENE
DRILLING EQUIPMENT: DRILL RIG
DRILLING METHOD: HOLLOW STEM AUGER
LOGGED BY: NEAL GRAHAM

## LEWIS COUNTY JUVENILE COURT

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-1

# B-2

| DEPTH (FEET) | SAMPLE NUMBER AND DEPTH | INCHES DRIVEN / RECOVERED | SPT "N" VALUE | U.S.G.S. | LITHOLOGY | SOIL DESCRIPTION | REMARKS AND LABORATORY TEST RESULTS |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | 3" Asphalt – 3" Crushed rock | |
| | | | | | | Orange–brown silty fine to coarse sand with fine to coarse gravel, medium dense, moist | |
| 5 | 1 | 18/9 | 27 | | | | |
| 10 | 2 | 18/8 | 28 | | | Grades to brown | |
| 15 | 3 | 18/16 | 54 | SM | | Grades to with lithic fragments, heavily decomposed, very dense, wet | |
| 20 | 4 | 18/16 | 50/5" | | | Grades to orange–brown, moist | |
| 25 | 5 | 18/9 | 50/6" | | | | |
| 30 | 6 | 18/12 | 50/6" | | | Grades to olive–gray with silt | |
| | | | | | | Groundwater encountered at 15 feet | |
| 35 | | | | | | | |
| 40 | | | | | | | |

LEGEND:

PROJECT NO.: 913-004-01
DATE: FEBRUARY 22, 2021
TOTAL DEPTH: 32 FEET
DRILLING CONTRACTOR: HOLOCENE
DRILLING EQUIPMENT: DRILL RIG
DRILLING METHOD: HOLLOW STEM AUGER
LOGGED BY: NEAL GRAHAM

## LEWIS COUNTY JUVENILE COURT

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-2

# B-3

| DEPTH (FEET) | SAMPLE NUMBER AND DEPTH | INCHES DRIVEN / RECOVERED | SPT "N" VALUE | U.S.G.S. | LITHOLOGY | SOIL DESCRIPTION | REMARKS AND LABORATORY TEST RESULTS |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | TS – Topsoil | |
| | 1 | 18/12 | 9 | SM | | Orange–brown silty fine to coarse sand with fine to coarse gravel, occasional cobbles, loose, moist | |
| 5 | | | | | | | |
| | | | | | | Groundwater not encountered | |
| 10 | | | | | | | |
| 15 | | | | | | | |
| 20 | | | | | | | |
| 25 | | | | | | | |
| 30 | | | | | | | |
| 35 | | | | | | | |
| 40 | | | | | | | |

LEGEND:

PROJECT NO.: 913-004-01
DATE: FEBRUARY 22, 2021
TOTAL DEPTH: 6.5 FEET
DRILLING CONTRACTOR: HOLOCENE
DRILLING EQUIPMENT: DRILL RIG
DRILLING METHOD: HOLLOW STEM AUGER
LOGGED BY: NEAL GRAHAM

## LEWIS COUNTY JUVENILE COURT

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-3

# B-4

| DEPTH (FEET) | SAMPLE NUMBER AND DEPTH | INCHES DRIVEN / RECOVERED | SPT "N" VALUE | U.S.G.S. | LITHOLOGY | SOIL DESCRIPTION | REMARKS AND LABORATORY TEST RESULTS |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | Gravel driveway | |
| 5 | 1 | 18/9 | 12 | SM | | Orange–brown silty fine to coarse sand with fine to coarse gravel, occasional cobbles, medium dense, moist | |
| | | | | | | Groundwater not encountered | |
| 10 | | | | | | | |
| 15 | | | | | | | |
| 20 | | | | | | | |
| 25 | | | | | | | |
| 30 | | | | | | | |
| 35 | | | | | | | |
| 40 | | | | | | | |

LEGEND:

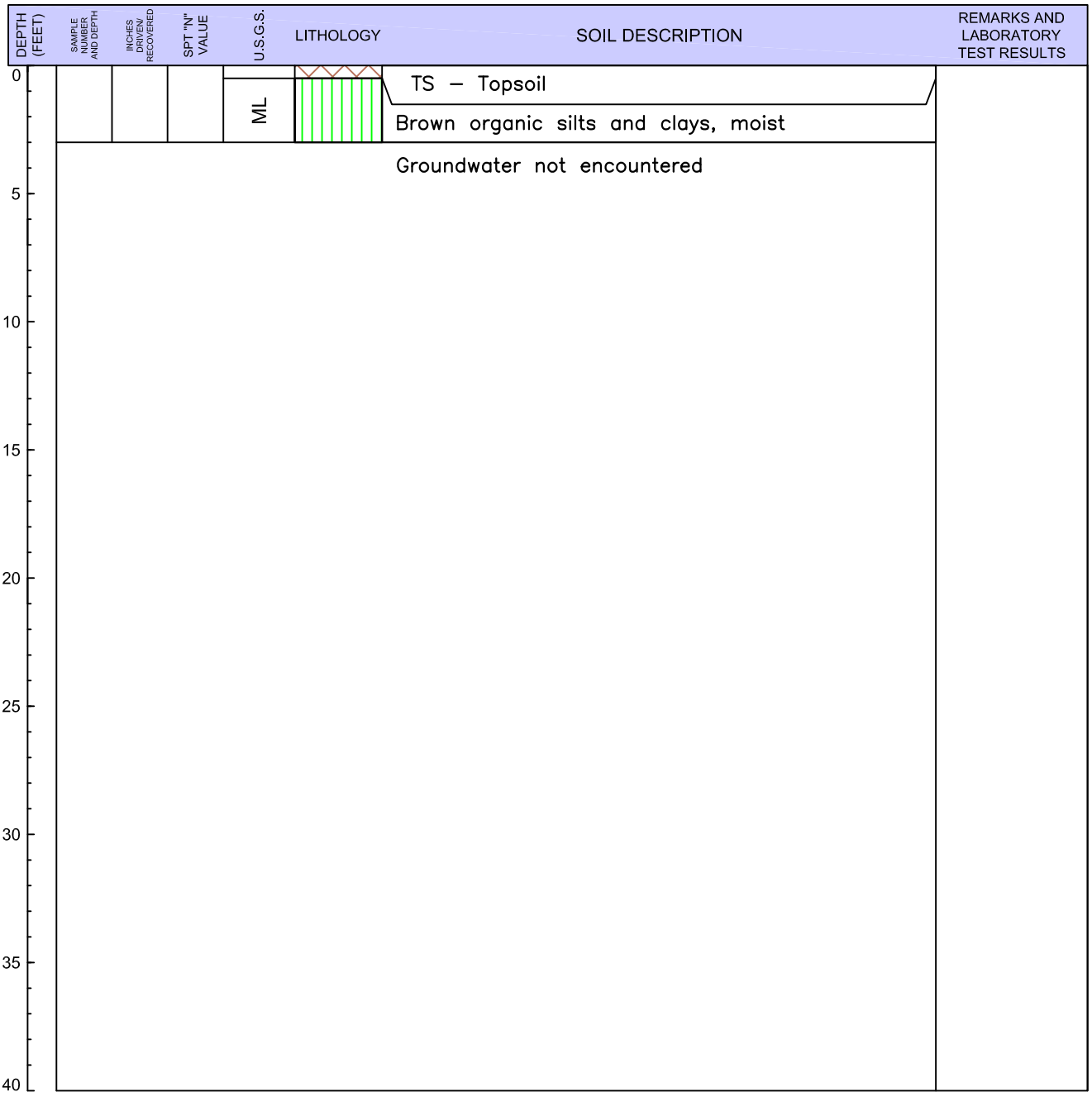
PROJECT NO.: 913-004-01
DATE: FEBRUARY 22, 2021
TOTAL DEPTH: 6.5 FEET
DRILLING CONTRACTOR: HOLOCENE
DRILLING EQUIPMENT: DRILL RIG
DRILLING METHOD: HOLLOW STEM AUGER
LOGGED BY: NEAL GRAHAM

LEWIS COUNTY JUVENILE COURT
CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-4

# B-5




LEGEND:

PROJECT NO.: 913-004-01
DATE: FEBRUARY 22, 2021
TOTAL DEPTH: 3 FEET
DRILLING EQUIPMENT: HAND AUGER
LOGGED BY: NEAL GRAHAM

## LEWIS COUNTY JUVENILE COURT

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-5

# ATTACHMENT B
# LABORATORY ANALYSES RESULTS

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-1
**Sample Name:** B-1 5.0' - 6.0'
**Depth:** 5 - 6 Feet

Moisture Content (%) 21.4%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 100.0 |
| 3/8 in. (9.5-mm) | 99.1 |
| No. 4 (4.75-mm) | 96.3 |
| No. 10 (2.00-mm) | 90.5 |
| No. 20 (.850-mm) | 86.5 |
| No. 40 (.425-mm) | 82.9 |
| No. 60 (.250-mm) | 78.2 |
| No. 100 (.150-mm) | 72.9 |
| No. 200 (.075-mm) | 66.9 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 0.0 |
| Fine Gravel | 3.7 |
| Coarse Sand | 5.8 |
| Medium Sand | 7.7 |
| Fine Sand | 16.0 |
| Fines | 66.9 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.00 |
| $D_{60}$ | 0.00 |
| $D_{90}$ | 1.70 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-1
**Sample Name:** B-1 6.0' - 6.5'
**Depth:** 6 - 6.5 Feet

Moisture Content (%) 40.0%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 95.2 |
| 3/8 in. (9.5-mm) | 92.2 |
| No. 4 (4.75-mm) | 88.4 |
| No. 10 (2.00-mm) | 79.5 |
| No. 20 (.850-mm) | 69.5 |
| No. 40 (.425-mm) | 54.4 |
| No. 60 (.250-mm) | 41.3 |
| No. 100 (.150-mm) | 31.5 |
| No. 200 (.075-mm) | 21.1 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 4.8 |
| Fine Gravel | 6.8 |
| Coarse Sand | 8.9 |
| Medium Sand | 25.1 |
| Fine Sand | 33.3 |
| Fines | 21.1 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.14 |
| $D_{60}$ | 0.53 |
| $D_{90}$ | 5.80 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Silty Sand**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-1
**Sample Name:** B-1 10.0' - 11.5'
**Depth:** 10 - 11.5 Feet

Moisture Content (%) 20.5%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 100.0 |
| 3/8 in. (9.5-mm) | 82.9 |
| No. 4 (4.75-mm) | 72.4 |
| No. 10 (2.00-mm) | 56.1 |
| No. 20 (.850-mm) | 42.9 |
| No. 40 (.425-mm) | 35.1 |
| No. 60 (.250-mm) | 29.4 |
| No. 100 (.150-mm) | 24.3 |
| No. 200 (.075-mm) | 19.3 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 0.0 |
| Fine Gravel | 27.6 |
| Coarse Sand | 16.3 |
| Medium Sand | 21.0 |
| Fine Sand | 15.8 |
| Fines | 19.3 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.26 |
| $D_{60}$ | 2.50 |
| $D_{90}$ | 14.00 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Silty Sand with Gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-2
**Sample Name:** B-2 5.0' - 6.5'
**Depth:** 5 - 6.5 Feet

Moisture Content (%) 33.6%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 95.2 |
| 3/8 in. (9.5-mm) | 78.9 |
| No. 4 (4.75-mm) | 71.7 |
| No. 10 (2.00-mm) | 64.8 |
| No. 20 (.850-mm) | 55.5 |
| No. 40 (.425-mm) | 46.3 |
| No. 60 (.250-mm) | 38.7 |
| No. 100 (.150-mm) | 32.0 |
| No. 200 (.075-mm) | 24.2 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 4.8 |
| Fine Gravel | 23.5 |
| Coarse Sand | 6.9 |
| Medium Sand | 18.5 |
| Fine Sand | 22.0 |
| Fines | 24.2 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.13 |
| $D_{60}$ | 1.20 |
| $D_{90}$ | 16.00 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Silty Sand with Gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-2
**Sample Name:** B-2 15.0' - 16.5'
**Depth:** 15 - 16.5 Feet

Moisture Content (%) 15.5%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 84.0 |
| 3/8 in. (9.5-mm) | 67.5 |
| No. 4 (4.75-mm) | 57.5 |
| No. 10 (2.00-mm) | 47.5 |
| No. 20 (.850-mm) | 37.3 |
| No. 40 (.425-mm) | 28.0 |
| No. 60 (.250-mm) | 21.7 |
| No. 100 (.150-mm) | 18.2 |
| No. 200 (.075-mm) | 14.3 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 16.0 |
| Fine Gravel | 26.5 |
| Coarse Sand | 10.0 |
| Medium Sand | 19.5 |
| Fine Sand | 13.6 |
| Fines | 14.3 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.50 |
| $D_{60}$ | 5.80 |
| $D_{90}$ | 24.00 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Silty Sand with Gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-2
**Sample Name:** B-2 25.0' - 26.5'
**Depth:** 25 - 26.5 Feet

Moisture Content (%) 15.6%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 92.0 |
| 3/8 in. (9.5-mm) | 75.9 |
| No. 4 (4.75-mm) | 58.6 |
| No. 10 (2.00-mm) | 44.3 |
| No. 20 (.850-mm) | 34.4 |
| No. 40 (.425-mm) | 28.6 |
| No. 60 (.250-mm) | 24.1 |
| No. 100 (.150-mm) | 20.1 |
| No. 200 (.075-mm) | 15.6 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 8.0 |
| Fine Gravel | 33.3 |
| Coarse Sand | 14.3 |
| Medium Sand | 15.7 |
| Fine Sand | 13.0 |
| Fines | 15.6 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.50 |
| $D_{60}$ | 5.00 |
| $D_{90}$ | 18.00 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Silty Sand with Gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-2
**Sample Name:** B-2 30.0' - 31.5'
**Depth:** 30 - 31.5 Feet

Moisture Content (%) 22.4%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 100.0 |
| 3/8 in. (9.5-mm) | 86.1 |
| No. 4 (4.75-mm) | 72.3 |
| No. 10 (2.00-mm) | 58.7 |
| No. 20 (.850-mm) | 48.5 |
| No. 40 (.425-mm) | 36.7 |
| No. 60 (.250-mm) | 22.3 |
| No. 100 (.150-mm) | 15.2 |
| No. 200 (.075-mm) | 10.6 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 0.0 |
| Fine Gravel | 27.7 |
| Coarse Sand | 13.7 |
| Medium Sand | 22.0 |
| Fine Sand | 26.1 |
| Fines | 10.6 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.07 |
| $D_{30}$ | 0.33 |
| $D_{60}$ | 2.10 |
| $D_{90}$ | 11.00 |
| **Cc** | 0.80 |
| **Cu** | 32.31 |

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel and Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-3
**Sample Name:** B-3 5.0' - 6.5'
**Depth:** 5 - 6.5 Feet

Moisture Content (%) 30.7%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 96.3 |
| 3/8 in. (9.5-mm) | 72.9 |
| No. 4 (4.75-mm) | 64.4 |
| No. 10 (2.00-mm) | 56.8 |
| No. 20 (.850-mm) | 49.1 |
| No. 40 (.425-mm) | 39.1 |
| No. 60 (.250-mm) | 31.1 |
| No. 100 (.150-mm) | 24.5 |
| No. 200 (.075-mm) | 18.0 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 3.7 |
| Fine Gravel | 31.9 |
| Coarse Sand | 7.7 |
| Medium Sand | 17.6 |
| Fine Sand | 21.1 |
| Fines | 18.0 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.23 |
| $D_{60}$ | 2.90 |
| $D_{90}$ | 16.00 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Silty Sand with Gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-5
**Sample Name:** B-5 0.0' - 1.0'
**Depth:** 0 - 1 Feet

Moisture Content (%) 29.1%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 100.0 |
| 3/8 in. (9.5-mm) | 93.3 |
| No. 4 (4.75-mm) | 89.2 |
| No. 10 (2.00-mm) | 86.6 |
| No. 20 (.850-mm) | 84.2 |
| No. 40 (.425-mm) | 81.3 |
| No. 60 (.250-mm) | 78.3 |
| No. 100 (.150-mm) | 75.0 |
| No. 200 (.075-mm) | 68.2 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 0.0 |
| Fine Gravel | 10.8 |
| Coarse Sand | 2.5 |
| Medium Sand | 5.3 |
| Fine Sand | 13.1 |
| Fines | 68.2 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.00 |
| $D_{60}$ | 0.00 |
| $D_{90}$ | 5.50 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-5
**Sample Name:** B-5 1.0' - 2.0'
**Depth:** 1 - 2 Feet

Moisture Content (%) 27.5%

| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 100.0 |
| 3/8 in. (9.5-mm) | 92.0 |
| No. 4 (4.75-mm) | 89.2 |
| No. 10 (2.00-mm) | 86.3 |
| No. 20 (.850-mm) | 83.8 |
| No. 40 (.425-mm) | 80.8 |
| No. 60 (.250-mm) | 76.9 |
| No. 100 (.150-mm) | 70.7 |
| No. 200 (.075-mm) | 59.1 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 0.0 |
| Fine Gravel | 10.8 |
| Coarse Sand | 2.9 |
| Medium Sand | 5.5 |
| Fine Sand | 21.7 |
| Fines | 59.1 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.00 |
| $D_{60}$ | 0.08 |
| $D_{90}$ | 6.00 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

# Gradation Analysis Summary Data

**Job Name:** Lewis County Juvenile Court Expansion
**Job Number:** 913-004-01
**Date Tested:** 3/8/21
**Tested By:** Neal Graham

**Sample Location:** B-5
**Sample Name:** B-5 2.0' - 3.0'
**Depth:** 2 - 3 Feet

Moisture Content (%) 39.2%

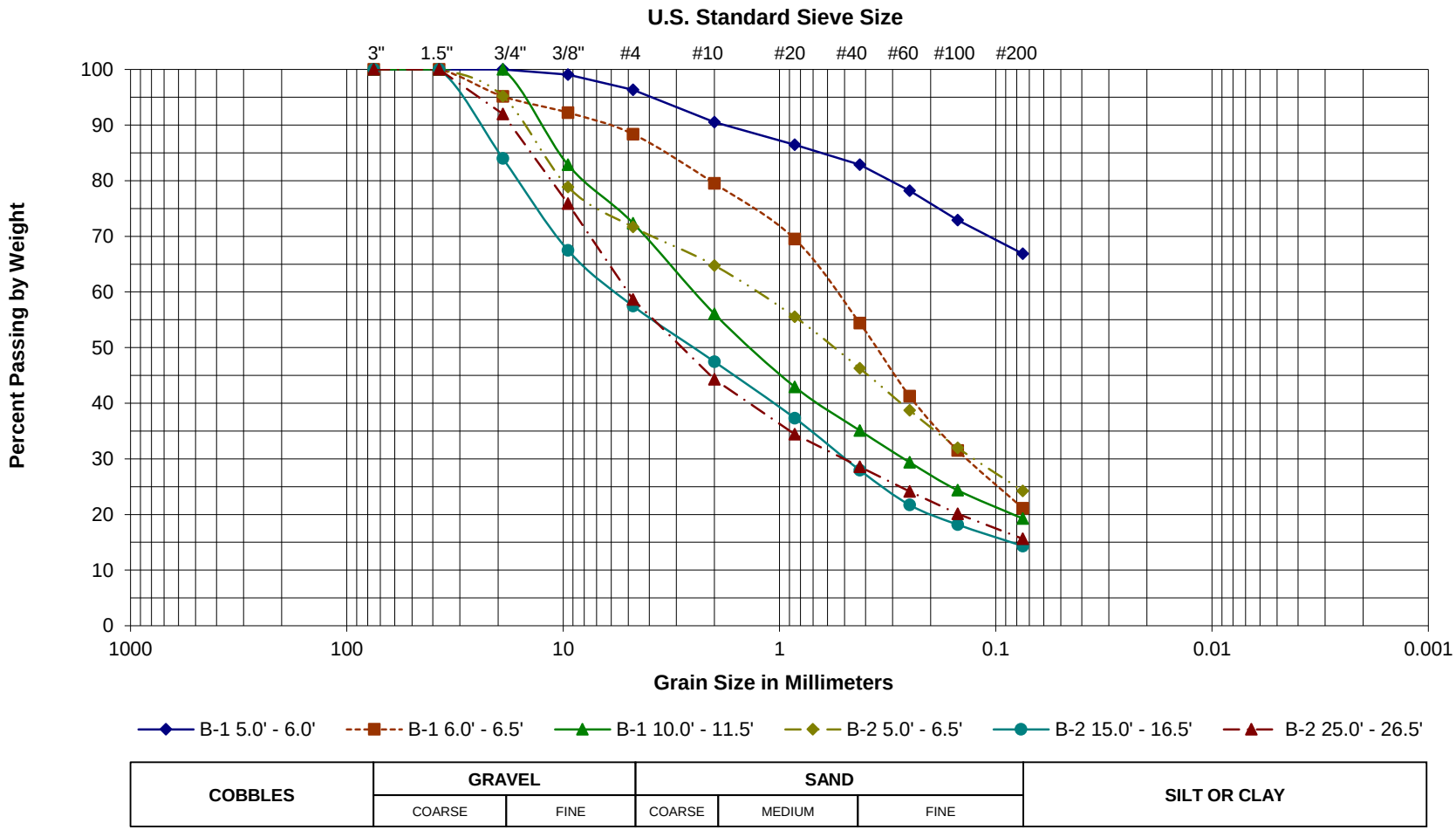
| Sieve Size | Percent Passing |
|---|---|
| 3.0 in. (75.0) | 100.0 |
| 1.5 in. (37.5) | 100.0 |
| 3/4 in. (19.0) | 100.0 |
| 3/8 in. (9.5-mm) | 100.0 |
| No. 4 (4.75-mm) | 99.3 |
| No. 10 (2.00-mm) | 98.1 |
| No. 20 (.850-mm) | 96.4 |
| No. 40 (.425-mm) | 94.1 |
| No. 60 (.250-mm) | 89.7 |
| No. 100 (.150-mm) | 81.0 |
| No. 200 (.075-mm) | 64.5 |

| Size Fraction | Percent by Weight |
|---|---|
| Coarse Gravel | 0.0 |
| Fine Gravel | 0.7 |
| Coarse Sand | 1.2 |
| Medium Sand | 3.9 |
| Fine Sand | 29.7 |
| Fines | 64.5 |
| **Total** | **100.0** |

| | |
|---|---|
| **LL** | - - |
| **PL** | - - |
| **PI** | - - |
| $D_{10}$ | 0.00 |
| $D_{30}$ | 0.00 |
| $D_{60}$ | 0.00 |
| $D_{90}$ | 0.25 |
| **Cc** | - - |
| **Cu** | - - |

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.



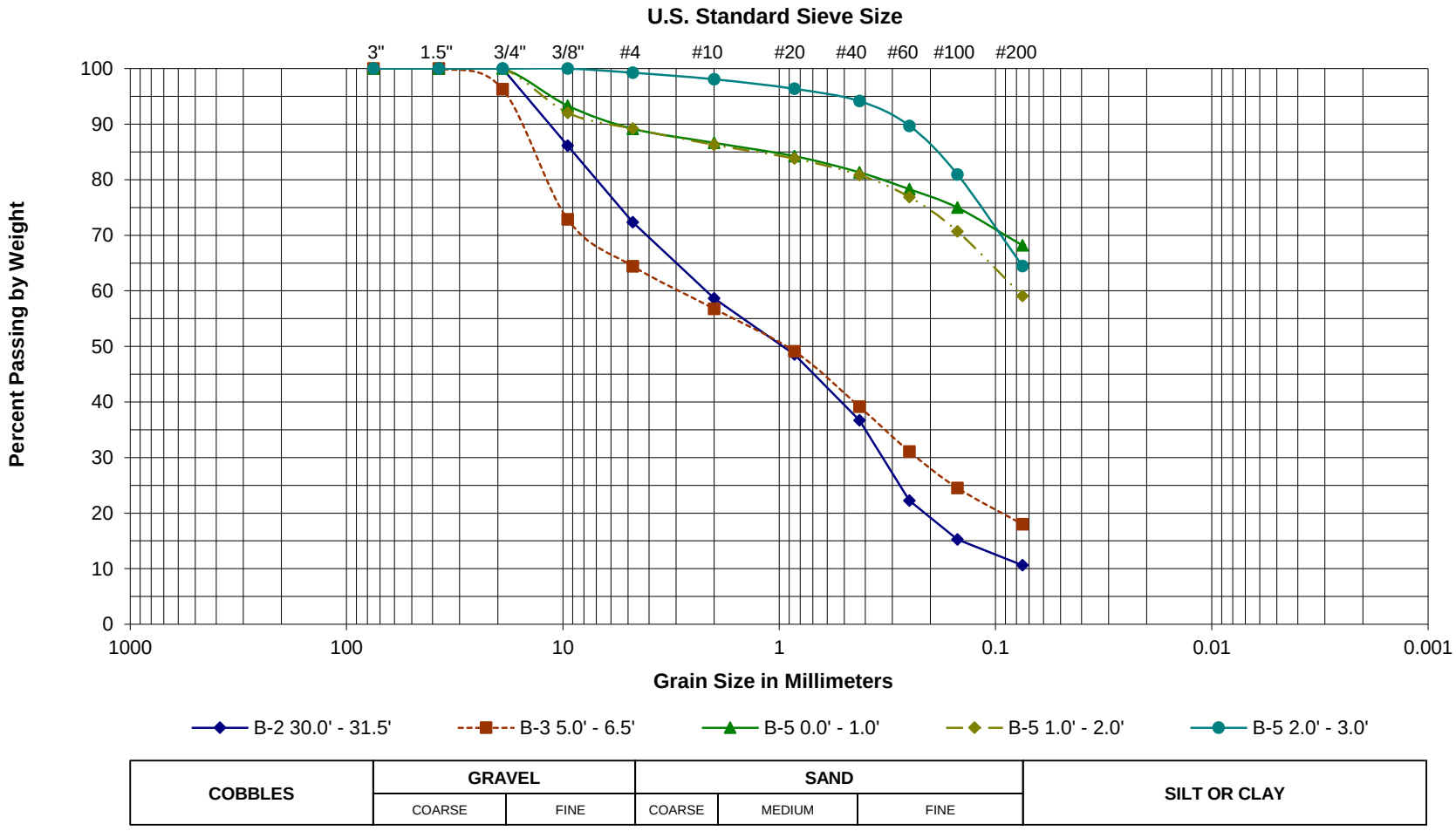

| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

LEWIS COUNTY JUVENILE COURT EXPANSION

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

LEWIS COUNTY JUVENILE COURT EXPANSION

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 2
Gradation Analysis Results

# ATTACHMENT C
# REPORT LIMITATIONS AND GUIDELINES FOR USE

# ATTACHMENT C

## REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This attachment provides information to help you manage your risks with respect to the use of this report.

### GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use of KMB Architects (Client) and their authorized agents. This report may be made available to regulatory agencies for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

Insight Geologic Inc. structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

### A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Insight Geologic, Inc. considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Insight Geologic specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, Insight Geologic should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

## SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or ground water fluctuations. Always contact Insight Geologic before applying a report to determine if it remains applicable.

## MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Insight Geologic reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

## GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from Insight Geologic's professional judgment and opinion. Insight Geologic's recommendations can be finalized only by observing actual subsurface conditions revealed during construction. Insight Geologic cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by Insight Geologic should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Insight Geologic for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

## A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having Insight Geologic confer with appropriate members of the design team after submitting the report. Also retain Insight Geologic to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Insight Geologic participate in pre-bid and pre-construction conferences, and by providing construction observation.

## DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a

geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

## GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with Insight Geologic and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

## CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor’s procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

## READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. Insight Geologic includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with Insight Geologic if you are unclear how these “Report Limitations and Guidelines for Use” apply to your project or site.

## GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.