

**PROJECT MANUAL**  
**Campbell County School District #1**  
**Campbell County High School**  
**Phase 3 – New High School Project**

Job No. 2512



**100% Construction Documents – VOLUME 2 OF 2**

**Owner:**

**Campbell County School District #1**

1000 Camel Drive  
Gillette, Wyoming 82716

**Architect:**

**Plan One/Architects**

225 W. Yellowstone Ave., Suite 4  
Cody, Wyoming 82414

**Design / Associate Architect:**

**DLR Group**

1401 Lawrence St., Suite 1000  
Denver, Co 80202

Set No:

Date: September 21, 2026

**Project Manual Index**  
**Campbell County School District #1**  
**Campbell County High School**  
**Phase 3 – New High School Project**  
**Volume 2 of 2**

DIVISION 21 – FIRE SUPPRESSION

|        |                                          |
|--------|------------------------------------------|
| 210000 | FIRE SUPPRESSION GENERAL REQUIREMENTS    |
| 210500 | COMMON WORK RESULTS FOR FIRE SUPPRESSION |
| 211000 | WATER-BASED FIRE-SUPPRESSION SYSTEMS     |

DIVISION 22 – PLUMBING

|        |                                                        |
|--------|--------------------------------------------------------|
| 220000 | PLUMBING GENERAL REQUIREMENTS                          |
| 220500 | COMMON WORK RESULTS FOR PLUMBING                       |
| 220519 | METERS AND GAGES FOR PLUMBING PIPING                   |
| 220523 | GENERAL-DUTY VALVES FOR PLUMBING PIPING                |
| 220529 | HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT |
| 220553 | IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT       |
| 220700 | PLUMBING INSULATION                                    |
| 221116 | DOMESTIC WATER PIPING                                  |
| 221119 | DOMESTIC WATER PIPING SPECIALTIES                      |
| 221316 | SANITARY WASTE AND VENT PIPING                         |
| 221319 | SANITARY WASTE PIPING SPECIALTIES                      |
| 221323 | SANITARY WASTE INTERCEPTORS                            |
| 221413 | FACILITY STORM DRAINAGE PIPING                         |
| 221423 | FACILITY STORM DRAINAGE PIPING SPECIALTIES             |
| 223100 | DOMESTIC WATER SOFTENERS                               |
| 223400 | FUEL-FIRED DOMESTIC WATER HEATERS                      |
| 224000 | PLUMBING FIXTURES                                      |

DIVISION 23 - HEATING VENTILATING AND AIR CONDITIONING

|        |                                                    |
|--------|----------------------------------------------------|
| 230000 | MECHANICAL GENERAL REQUIREMENTS                    |
| 230500 | COMMON WORK RESULTS FOR HVAC                       |
| 230513 | COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT       |
| 230519 | METERS AND GAGES FOR HVAC PIPING                   |
| 230523 | GENERAL-DUTY VALVES FOR HVAC PIPING                |
| 230529 | HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT |
| 230553 | IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT       |
| 230593 | TESTING, ADJUSTING, AND BALANCING FOR HVAC         |
| 230700 | INSULATION PIPING AND DUCTING                      |
| 230900 | INSTRUMENTATION AND CONTROL FOR HVAC               |
| 230993 | SEQUENCE OF OPERATIONS FOR HVAC CONTROLS           |
| 232300 | REFRIGERANT PIPING                                 |
| 231123 | FACILITY NATURAL-GAS PIPING                        |

|           |                                                     |
|-----------|-----------------------------------------------------|
| 232113    | HYDRONIC PIPING                                     |
| 232123    | HYDRONIC PUMPS                                      |
| 232500    | HVAC WATER TREATMENT                                |
| 233113    | METAL DUCTS                                         |
| 233300    | AIR DUCT ACCESSORIES                                |
| 233423    | HVAC POWER VENTILATORS                              |
| 233600    | AIR TERMINAL UNITS                                  |
| 233713    | DIFFUSERS, REGISTERS, GRILLES                       |
| 233723    | HVAC LOUVERS                                        |
| 233813    | COMMERCIAL-KITCHEN HOODS                            |
| 235216    | CONDENSING BOILERS                                  |
| 237223.23 | PACKAGED, OUTDOOR, HEAT WHEEL ENERGY RECOVERY UNITS |
| 237416.11 | PACKAGED ROOFTOP AIR CONDITIONING UNITS             |
| 237423.13 | DIRECT FIRED, OUTDOOR, MAKEUP-AIR UNITS             |
| 238126    | SPLIT SYSTEM AIR CONDITIONERS                       |
| 238239    | UNIT HEATERS                                        |

#### DIVISION 26 – ELECTRICAL

|           |                                                              |
|-----------|--------------------------------------------------------------|
| 260519    | LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES           |
| 260526    | GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS                 |
| 260529    | HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS                  |
| 260533    | RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS                    |
| 260544    | SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING |
| 260548.16 | SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS                      |
| 260553    | IDENTIFICATION FOR ELECTRICAL SYSTEMS                        |
| 260572    | OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY            |
| 260573    | OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY             |
| 260574    | OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY                |
| 260923    | LIGHTING CONTROL DEVICES                                     |
| 262200    | LOW-VOLTAGE TRANSFORMERS                                     |
| 262413    | SWITCHBOARDS                                                 |
| 262416    | PANELBOARDS                                                  |
| 262713    | ELECTRICITY METERING                                         |
| 262726    | WIRING DEVICES                                               |
| 262813    | FUSES                                                        |
| 262816    | ENCLOSED SWITCHES AND CIRCUIT BREAKERS                       |
| 262913    | ENCLOSED CONTROLLERS                                         |
| 263213.16 | GAS-ENGINE-DRIVEN GENERATOR SETS                             |
| 263323.11 | CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING             |
| 263600    | TRANSFER SWITCHES                                            |
| 264313    | SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS   |
| 265119    | LED INTERIOR LIGHTING                                        |
| 265213    | EMERGENCY AND EXIT LIGHTING                                  |
| 265613    | LIGHTING POLES AND STANDARDS                                 |
| 265619    | LED EXTERIOR LIGHTING                                        |

## DIVISION 27 – COMMUNICATIONS

|           |                                                              |
|-----------|--------------------------------------------------------------|
| 270010    | COMMUNICATIONS GENERAL PROVISIONS                            |
| 270526    | GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS             |
| 270528    | PATHWAYS FOR COMMUNICATIONS SYSTEMS                          |
| 270544    | SLEEVES & SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS & CABLING |
| 271100    | COMMUNICATIONS EQUIPMENT ROOM FITTINGS                       |
| 271300    | COMMUNICATIONS BACKBONE CABLING                              |
| 271500    | COMMUNICATIONS HORIZONTAL CABLING                            |
| 274000    | AUDIOVISUAL SYSTEMS                                          |
| 274116    | Performance AV Systems                                       |
| 275123.50 | EDUCATIONAL PUBLIC ADDRESS, INTERCOM, AND PROGRAM SYSTEMS    |

## DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

|        |                                                                |
|--------|----------------------------------------------------------------|
| 280010 | ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS              |
| 280513 | CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY       |
| 280528 | PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY                    |
| 280544 | SLEEVES & SEALS FOR ELEC. SAFETY & SECURITY PATHWAYS & CABLING |
| 281300 | ELECTRONIC ACCESS CONTROL SYSTEMS                              |
| 282300 | SECURITY CAMERA SYSTEMS                                        |
| 283111 | DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM                         |
| 284800 | AREA OF RESCUE ASSISTANCE SYSTEMS                              |

## DIVISION 31 - EARTHWORK

|           |                        |
|-----------|------------------------|
| 311000    | Site Clearing          |
| 312100    | Watering               |
| 312110    | Dewatering             |
| 312201    | Grading                |
| 312316    | Excavation             |
| 312316.13 | Trenching              |
| 312323    | Fill                   |
| 312500    | Engineering Fabric     |
| 313700    | Riprap                 |
| 316613    | Rammed Aggregate Piers |

## DIVISION 32 - EXTERIOR IMPROVEMENTS

|           |                                         |
|-----------|-----------------------------------------|
| 320516    | Aggregates for Ext Improvements         |
| 321123    | Aggregate Base Courses                  |
| 321216    | Asphalt Paving                          |
| 321313    | Concrete Paving                         |
| 321314    | Concrete Mow Bands and Headers          |
| 321500    | Aggregate Surfacing                     |
| 321723.13 | Painted Pavement Markings               |
| 321726    | Tactile Warning Surfacing               |
| 322920    | Irrigation – City of Gillette Standards |
| 323113    | Chain Link Fence & Gates                |
| 323119    | Decorative Metal Fences and Gates       |
| 323400    | Traffic Signs                           |
| 323900    | Manufactured Site Specialties           |
| 329113    | Soil Preparation                        |



|        |                      |
|--------|----------------------|
| 329200 | Turf and Grasses     |
| 329213 | Hydro Mulching       |
| 329300 | Plants               |
| 329400 | Planting Accessories |

#### DIVISION 33 - UTILITIES

|        |                                              |
|--------|----------------------------------------------|
| 330200 | Underground Utilities                        |
| 330500 | Manholes                                     |
| 330510 | Adjusting Existing Utility Structures        |
| 331100 | Water Main                                   |
| 331110 | Water Valves and Valve Boxes                 |
| 331120 | Fire Hydrants                                |
| 331500 | Water Service                                |
| 331200 | Corrosion Protection of Plastic Pipe Systems |
| 331210 | Disinfecting Water Piping Systems            |
| 333100 | Sanitary Sewer Piping                        |
| 334100 | Subdrainage                                  |
| 334200 | Storm Sewer Piping                           |
| 334210 | Culverts                                     |
| 334250 | Storm Sewer Inlets                           |

#### DIVISION 34 – TRANSPORTATION

|        |                           |
|--------|---------------------------|
| 340100 | Temporary Traffic Control |
|--------|---------------------------|

END OF VOLUME 2 INDEX

## SECTION 210000 - FIRE-SUPPRESSION GENERAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. Furnish and install an automatic sprinkler system to protect as indicated herein and as shown on the Drawings. Connect system to a water supply of sufficient pressure to ensure full and sustained water discharge immediately from sprinkler heads when opened by fire at rated heat temperatures. Water supply shall conform to NFPA water supply requirements with considerations given to the reliability of the public water supply, taking into account probable minimum pressure conditions. The Contractor shall verify site water pressure before submitting shop drawings.
- B. All portions of the systems shall be installed in accordance with the drawings, details, and specifications and as required by jurisdictional authorities and codes. Jurisdictional authorities and codes shall take precedence over plans, details and specifications in the event of a dispute between the requirements of contract documents and jurisdictional authorities or codes.
- C. The position is taken that the Owner is entitled to a project which meets or exceeds the minimum requirements of nationally recognized fire protection standards. All efforts and installations shall be directed toward this end. All deficiencies as noted by fire rating bureaus, insurance service offices or jurisdictional authorities shall be corrected. No extra charges will be allowed on this account.
- D. The intent of these specifications is to describe the complete systems to be installed, including minor details of work or materials not specifically mentioned or shown, but necessary for the successful operation and completion of the installation.
- E. The specifications and fire sprinkler drawings provide performance based guidelines for fire sprinkler head placement and pipe routing in critical areas. The fire sprinkler contractor is responsible design of the new fire sprinkler systems, preparation of final shop drawings based on the proceeding notes, drawings, and the project specifications, and the complete installation of the fire sprinkler system which meets all of the requirements outlined within these drawings, specifications, and code(s). The fire sprinkler contractor shall provide as-built drawings upon completion of work which reflect actual installation conditions.
- F. Fire sprinkler contractor shall develop, produce, and submit engineered fire sprinkler design calculations, product data sheets, and drawings (shop drawings) to the architect / engineer for review and approval. Thereafter submit the shop drawing to the authority having jurisdiction (AHJ) for review and approval. After AHJ has reviewed and approved the calculations, product data sheets, and drawings, fire sprinkler contractor shall submit the drawings and calculations to the engineer for final review and approval prior to any fire sprinkler system installation. These final acceptance sets shall have all agencies' stamps of review and acceptance. Where there is conflict between the Contract Drawings and/or Specifications, and the recommendations of the jurisdictional

authorities, the conflict shall be brought to the attention of the Architect at least ten (10) days prior to bidding or be resolved at no cost to the Owner.

- G. Refer to architectural plans and fire sprinkler plans for complete sections, elevations, and floor plan details/notes. Coordinate with full drawing package for scope of work required by this contract.
- H. Upon the contractors request, electronic drawing files of the projects floor plans / reflective ceiling plans can be provided for convenience and use in the preparation of shop drawings related to the project subject to agreed upon terms and conditions. Contractor shall be required to submit an acceptance letter of the terms and conditions prior to release of the electronic drawings. Coordinate with the project engineer for additional requirements.
- I. The preparation of all shop drawings and hydraulic calculations shall be accomplished by a registered engineer, licensed in the state of Wyoming if required by local authorities. At a minimum, work shall be completed by a NICET level 3 technician.
- J. Work to be performed under this section shall include, but not be limited to the following:
  - 1. Automatic fire sprinkler systems.
    - a. Wet Pipe Flow Switch System.
      - 1) Pipe and fittings.
      - 2) Hangers and supports.
      - 3) Earthquake bracing.
      - 4) Valves.
      - 5) Alarms.
      - 6) Flow Switches.
      - 7) Specialties.
- K. The following areas shall be furnished with an automatic fire protection system of type or types as required:
  - 1. Wet pipe flow switch system.
    - a. The entire new high school building.
- L. Coordinate all work to accommodate the different fire suppression systems. Coordinate work with the fire alarm contractor and electrician. Refer to all Division 21 Specifications, Fire Sprinkler Drawings, Electrical Drawings, and Electrical Specifications before bidding and constructing.

## 1.2 RELATED WORK

- A. All work performed under this section of the specifications shall be subject to the requirements of both the General and Special Conditions and the Mechanical and Plumbing Specifications.

### 1.3 REGULATORY AGENCIES

- A. The term jurisdictional authority used in this section of the specification shall include, as applicable, but not be limited to the following:
  - 1. Local Building Department and Fire Department.
  - 2. Wyoming State Fire Marshal
  - 3. Insurance Services Office or Insuring Authority having jurisdiction.
  - 4. Owner.
- B. The design and installation of all systems of fire protection shall conform to all requirements of applicable codes and publications herein defined:
  - 1. International Building Code
  - 2. International Fire Code
  - 3. NFPA 13
  - 4. NFPA 10
  - 5. NFPA 17
  - 6. All State and local ordinances
  - 7. Underwriters' Laboratories
  - 8. Industrial Risk Insurers/Factory Mutual
  - 9. American Society of Testing Materials
  - 10. American National Standards Institute
  - 11. Occupation Safety & Health Act (OSHA)

### 1.4 SUBMITTALS

- A. The successful Contractor shall provide submittal data as required under other portions of this specification. Submittals shall conform to the instructions set forth in the General and Special Conditions of these specifications entitled Shop Drawings and Submittals.
- B. Submit shop drawings (floor plans - detailed working drawings), showing dimensions, ducts, lights, or other items affecting the fire protection systems to jurisdictional agencies for review and approval, including all Authorities Having Jurisdiction. All items identified in NFPA 13 for proper working drawings shall be complied with. The Architect will reject all submittals not in compliance.
- C. Fire sprinkler contractor shall develop, produce, and submit engineered fire sprinkler design calculations, product data sheets, and drawings (shop drawings) to the architect / engineer for review and approval. Thereafter submit the shop drawing to the authority having jurisdiction (AHJ) for review and approval. After AHJ has reviewed and approved the calculations, product data sheets, and drawings, fire sprinkler contractor shall submit the drawings and calculations to the engineer for final review and approval prior to any fire sprinkler system installation. These final acceptance sets shall have all agencies' stamps of review and acceptance. Where there is conflict between the Contract Drawings and/or Specifications, and the recommendations of the jurisdictional authorities, the conflict shall be brought to the attention of the Architect at least ten (10) days prior to bidding or be resolved at no cost to the Owner.

- D. Architect's review will be for general location only. It will be the Contractor's responsibility to check his drawings for interference and to do shop fabrication from measurements taken at the job site.
- E. Work on the project shall not begin until plans have been reviewed by the Architect.
- F. Full catalog information shall be submitted for approval for all materials provided.
- G. Submittals shall be compiled and submitted in PDF format. The PDF method shall be presented as one (1) entire package per submittal section with each item in the respective submittal division clearly tagged.
- H. Each item submitted must be typewritten and clearly marked as follows for purposes of identification and record. Submittals not typewritten or not marked as described below will be rejected and returned without review.
- I. A charge of \$50.00 per drawing will be charged for electronic drawings. Associated Construction Engineering, Inc. reserves the right to waive this fee.
- J. The preparation of all shop drawings and hydraulic calculations shall be accomplished by a registered engineer, licensed in the state of Wyoming if required by local authorities. At a minimum, work shall be completed by a NICET level 3 technician.

#### 1.5 JOB CONDITIONS

- A. The Contractor shall investigate the structural, mechanical, plumbing, electrical, and finished conditions affecting the piping, and shall arrange the equipment accordingly; furnishing required fittings, offsets and accessories. Route fire protection piping to avoid interference with ductwork and drain piping. In the event it becomes necessary to make field changes in pipe locations due to building construction, the Contractor shall consult with the Architect before making any changes. Any such changes required shall be made without added cost to the Owner.
- B. The Contractor shall determine, and be responsible for, the proper locations and type of inserts for hangers, chases, sleeves, and other openings in the construction required for fire protection work, and shall obtain this information well in advance of the construction progress to avoid delay of the work.
- C. The drawings indicate approximate locations of sprinkler equipment. Contractor is responsible for final locations and routing.
- D. All fees and permits specifically required for fire protection work, not obtained by others as specified elsewhere shall be applied for and paid for by this Contractor.
- E. All systems of fire protection shall be installed by a licensed (for the location of installation) Fire Protection Contractor, fully experienced in fire protection installation as specified herein.

- F. Fire Protection Contractors may be required to provide in writing, specific information as to successfully completed projects and references to show cause as to why they should be considered acceptable to the Architect.

#### 1.6 RECORD DRAWINGS

- A. One approved set of drawings shall be maintained on the job at all times.
- B. The Contractor shall furnish to the Architect/Engineer a marked print showing the location of all mechanical equipment, plumbing fixtures, piping, etc. The location of any item which deviates from the bid documents shall be accurately drawn and dimensioned.
- C. One (1) complete full size paper copy and a scanned (in color) PDF electronic copy of the as-built drawings shall be provided.

#### 1.7 OPERATION AND MAINTENANCE MANUALS

- A. At the time orders are placed for any item of equipment requiring service or operating maintenance, the Contractor shall request the manufacturer furnish three (3) copies and one (1) electronic PDF copy of OPERATION AND MAINTENANCE INSTRUCTIONS for each piece of equipment. These shall be included in the brochure of equipment.
- B. Operation and Maintenance manuals shall contain letter of one (1) year warranty with the start date listed.
- C. Operation and Maintenance manuals shall contain all startup reports associated with fire sprinkler systems / equipment.
- D. Manuals shall include the following:
  - 1. As-Built Drawings
  - 2. NFPA 25
  - 3. Catalog cut sheets of all materials installed
  - 4. Equipment maintenance manuals

#### 1.8 TRAINING

- A. The Fire Protection Contractor shall instruct the Owner in the operation of the systems. Instruction shall continue until the Owner is fully satisfied that he understands the operation of his system.

#### 1.9 GUARANTEES AND WARRANTIES

- A. The Fire Protection Contractor shall guarantee to the Owner in writing, all equipment and workmanship for a period of one (1) year after the fire protection system has been

placed in continuous service and has been accepted by all authorities having jurisdiction.

- B. The Fire Protection Contractor shall not be held responsible for improper or negligent maintenance by the Owner after operating and maintenance indoctrination has been given the Owner.
- C. During the warranty period, if system or equipment issues arise, the Contractor shall submit a warranty report to the Architect/Engineer identifying the issue and what was done to correct the issue. The warranty report shall identify the date the issue was discovered, when the issue was resolved, and the key personal involved in resolving the issue.

#### 1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

END OF SECTION 210000

## SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Sleeves.
  - 3. Escutcheons.
  - 4. Supports and anchorages.
- B. Refer to Fire Protection drawings for additional information and instructions.

#### 1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### 1.3 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.



- C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## PART 2 - PRODUCTS

### 2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.2 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12.

### 2.3 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

### 2.4 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.5 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated.

## 2.6 PIPE HANGERS AND SUPPORT

- A. Refer to the drawings and specifications for additional piping requirements.
- B. General pipe hanger and support requirements unless otherwise noted:
  - 1. All pipe hangers and supports shall be hot dipped galvanized steel, electro-galvanized steel, or zinc plated steel.

## 2.7 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, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 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 Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 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, 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.

END OF SECTION 210500

## SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following fire-suppression piping inside the building:
  - 1. Wet-pipe sprinkler systems.
- B. See Division 28 Section "Digital, Addressable Fire Alarm System" for alarm devices not specified in this Section.
- C. See Fire Protection Drawings for additional information and instructions.

#### 1.2 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
  - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
  - 2. Sprinkler Occupancy Hazard Classifications:
    - a. Building Service Areas: Ordinary Hazard, Group 1.
    - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
    - c. General Storage Areas: Ordinary Hazard, Group 1.
    - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
    - e. Office and Public Areas: Light Hazard.
  - 3. Minimum Density for Automatic-Sprinkler Piping Design:
    - a. Light-Hazard Occupancy: 0.10 gpm/sq.ft. over 1500 sq. ft.
    - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq.ft. over 1500 sq. ft.
  - 4. Maximum Protection Area per Sprinkler:
    - a. Office Spaces: 225 sq. ft.

- b. Storage Areas: 130 sq. ft.
  - c. Mechanical Equipment Rooms: 130 sq. ft.
  - d. Electrical Equipment Rooms: 130 sq. ft.
  - e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
- 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
  - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
  - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
- C. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

#### 1.4 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
  - 1. Refer to Specification Section 210000 – Fire Suppression General Requirements for additional instructions.
- C. Field test reports and certificates.
- D. Field quality-control test reports.
- E. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  - 1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer, licensed in the State of Wyoming.
- B. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight (Sch. 40) Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
  - 1. Cast-Iron Threaded Flanges: ASME B16.1.
  - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
  - 3. Gray-Iron Threaded Fittings: ASME B16.4.
  - 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
  - 5. Steel Threaded Couplings: ASTM A 865.
- B. Threaded-End, Standard-Weight (Sch. 40) Hot-Dipped Galvanized-Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
  - 1. Hot-Dipped Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
  - 2. Hot-Dipped Galvanized-Steel Couplings: ASTM A 865/A 865M, threaded.
  - 3. Hot-Dipped Galvanized Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- C. Grooved-End, Standard-Weight (Sch.10) Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with field-formed roll grooved ends.
  - 1. Grooved-Joint Piping Systems:
    - a. Manufacturers:
      - 1) Anvil International, Inc.
      - 2) Central Sprinkler Corp.
      - 3) Ductilic, Inc.
      - 4) JDH Pacific, Inc.
      - 5) National Fittings, Inc.
      - 6) Shurjoint Piping Products, Inc.
      - 7) Southwestern Pipe, Inc.
      - 8) Star Pipe Products; Star Fittings Div.
      - 9) Victaulic Co. of America.
      - 10) Ward Manufacturing.

- b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
- c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

## 2.3 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
  - 1. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
- B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
  - 1. Manufacturers:
    - a. Central Sprinkler Corp.
    - b. Fire-End and Croker Corp.
    - c. Viking Corp.
    - d. Victaulic Co. of America.
- C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
  - 1. Manufacturers:
    - a. AGF Manufacturing Co.
    - b. Central Sprinkler Corp.
    - c. G/J Innovations, Inc.
    - d. Triple R Specialty of Ajax, Inc.
- D. Flexible Sprinkler Hose Fitting:
  - 1. Manufacturers:
    - a. Central Sprinkler Corp.
    - b. Viking Corp.
    - c. Victaulic Co. of America
  - 2. Standard: UL 1474 listed and FMG approved.
  - 3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
  - 4. Pressure Rate: 175-psig.
  - 5. Size: Same as connected piping for sprinkler.



## 2.4 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

- 1) Global Safety Products, Inc.
- 2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with grooved ends.

a. Manufacturers:

- 1) Central Sprinkler Corp.
- 2) Global Safety Products, Inc.
- 3) McWane, Inc.; Kennedy Valve Div.
- 4) Mueller Company.
- 5) NIBCO.
- 6) Pratt, Henry Company.
- 7) Victaulic Co. of America.

C. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:

- a. AFAC Inc.
- b. American Cast Iron Pipe Co.; Waterous Co.
- c. Central Sprinkler Corp.
- d. Clow Valve Co.
- e. Crane Co.; Crane Valve Group; Crane Valves.
- f. Crane Co.; Crane Valve Group; Jenkins Valves.
- g. Firematic Sprinkler Devices, Inc.
- h. Globe Fire Sprinkler Corporation.
- i. Grinnell Fire Protection.
- j. Hammond Valve.
- k. Matco-Norca, Inc.
- l. McWane, Inc.; Kennedy Valve Div.
- m. Mueller Company.
- n. NIBCO.
- o. Potter-Roemer; Fire Protection Div.
- p. Reliable Automatic Sprinkler Co., Inc.
- q. Star Sprinkler Inc.
- r. Stockham.
- s. United Brass Works, Inc.
- t. Venus Fire Protection, Ltd.

- u. Victaulic Co. of America.
- v. Watts Industries, Inc.; Water Products Div.

D. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

- 1) Crane Co.; Crane Valve Group; Crane Valves.
- 2) Hammond Valve.
- 3) NIBCO.
- 4) United Brass Works, Inc.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

a. Manufacturers:

- 1) Clow Valve Co.
- 2) Crane Co.; Crane Valve Group; Crane Valves.
- 3) Crane Co.; Crane Valve Group; Jenkins Valves.
- 4) Hammond Valve.
- 5) Milwaukee Valve Company.
- 6) Mueller Company.
- 7) NIBCO.
- 8) Red-White Valve Corp.
- 9) United Brass Works, Inc.

E. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

- 1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch .Visual.
- 2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

a. Manufacturers:

- 1) Milwaukee Valve Company.
- 2) NIBCO.
- 3) Victaulic Co. of America.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

a. Manufacturers:

- 1) Central Sprinkler Corp.
- 2) Grinnell Fire Protection.
- 3) McWane, Inc.; Kennedy Valve Div.
- 4) Milwaukee Valve Company.
- 5) NIBCO.
- 6) Victaulic Co. of America.

## 2.5 UNLISTED GENERAL-DUTY VALVES

- A. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
- B. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
- C. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

## 2.6 SPECIALTY VALVES

- A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating.

### 1. Manufacturers:

- a. AFAC Inc.
- b. Central Sprinkler Corp.
- c. Firematic Sprinkler Devices, Inc.
- d. Globe Fire Sprinkler Corporation.
- e. Grinnell Fire Protection.
- f. Reliable Automatic Sprinkler Co., Inc.
- g. Star Sprinkler Inc.
- h. Venus Fire Protection, Ltd.
- i. Victaulic Co. of America.
- j. Viking Corp.

- B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

### 1. Manufacturers:

- a. AFAC Inc.
- b. Grinnell Fire Protection.

## 2.7 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

### B. Manufacturers:

- 1. AFAC Inc.
- 2. Central Sprinkler Corp.
- 3. Firematic Sprinkler Devices, Inc.
- 4. Globe Fire Sprinkler Corporation.
- 5. Grinnell Fire Protection.
- 6. Reliable Automatic Sprinkler Co., Inc.
- 7. Star Sprinkler Inc.
- 8. Venus Fire Protection, Ltd.

9. Victaulic Co. of America.
  10. Viking Corp.
- C. Automatic Sprinklers: Wet type with heat-responsive element complying with the following:
1. UL 199, for nonresidential applications.
  2. UL 1767, for early-suppression, fast-response applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- E. Sprinkler Spray, Standard Response: types, features, and options as follows:
1. Pendent sprinklers.
  2. Recessed sprinklers, including escutcheon.
  3. Sidewall sprinklers.
  4. Upright sprinklers.
- F. Sprinkler Spray, Quick Response: types, features, and options as follows:
1. Pendent sprinklers.
  2. Recessed sprinklers, including escutcheon.
  3. Sidewall sprinklers.
  4. Upright sprinklers.
- G. Sprinklers, Automatic Dry with Heat-Responsive Element:
1. Standard Spray, Quick Response:
    - a. Upright.
    - b. Pendent.
    - c. Recessed pendent.
    - d. Flat, Concealed pendent.
    - e. Horizontal sidewall.
    - f. Flat, concealed horizontal sidewall.
  2. Special Sprinklers:
    - a. ESFR.
- H. Sprinkler Finishes:
1. All other areas: Chrome or brass, painted as indicated on the fire protection drawings.
- I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, 2 piece, with 1-inch vertical adjustment.
  2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

- J. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

## 2.8 FIRE DEPARTMENT CONNECTIONS

### A. Manufacturers:

1. AFAC Inc.
2. Central Sprinkler Corp.
3. Elkhart Brass Mfg. Co., Inc.
4. Fire-End and Croker Corp.
5. Fire Protection Products, Inc.
6. GMR International Equipment Corporation.
7. Guardian Fire Equipment Incorporated.
8. Potter-Roemer; Fire-Protection Div.
9. Reliable Automatic Sprinkler Co., Inc.
10. United Brass Works, Inc.

- B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR."

1. Type: Exposed, projecting, with two inlets and escutcheon plate. Coordinate type with the authority having jurisdiction.
2. Finish: Rough brass.

## 2.9 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.

- B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

### 1. Manufacturers:

- a. ADT Security Services, Inc.
- b. Grinnell Fire Protection.
- c. ITT McDonnell & Miller
- d. Potter Electric Signal Company.
- e. System Sensor.
- f. Viking Corp.
- g. Watts Industries, Inc.; Water Products Div.

- C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

- 1. Manufacturers:

- a. McWane, Inc.; Kennedy Valve Div.
  - b. Potter Electric Signal Company.
  - c. System Sensor.

## 2.10 PRESSURE GAGES

- A. Manufacturers:

- 1. AGF Manufacturing Co.
  - 2. AMETEK, Inc.; U.S. Gauge.
  - 3. Brecco Corporation.
  - 4. Dresser Equipment Group; Instrument Div.
  - 5. Marsh Bellofram.
  - 6. WIKA Instrument Corporation.

- B. Description: UL 393, 3-1/2- to 4-1/2-inch diameter, dial pressure gage with range of 0 to 250 psig minimum.

- 1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

## 2.11 PIPE HANGERS AND SUPPORT

- A. Refer to the drawings and specifications for additional piping requirements.

- B. General pipe hanger and support requirements unless otherwise noted:

- 1. All pipe hangers and supports shall be hot dipped galvanized steel, electro-galvanized steel, or zinc plated steel.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS, GENERAL

- A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- B. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded or grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

### 3.2 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Refer to Fire Protection Drawing FP0.1 for project specific piping application.
- B. All areas other than the room listed below in paragraph 3.2.C:
  - 1. NPS 2 and Smaller: Threaded-end, black standard-weight (Sch. 40) steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
  - 2. NPS 2-1/2 and Larger: Threaded-end, black standard-weight (Sch. 10) steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
  - 3. NPS 2-1/2 and Larger: Grooved-end, black standard-weight (Sch. 10) steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

### 3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13.
    - a. Shutoff Duty: Use butterfly or gate valves.
  - 2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.
    - a. Shutoff Duty: Use butterfly or gate valves.
    - b. Throttling Duty: Use globe valves.

### 3.4 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
  - 1. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

### 3.5 WATER-SUPPLY CONNECTION

- A. Connect fire-suppression piping to the building's existing fire sprinkler riser assembly. Refer to Fire Protection drawing detail 1/FP-001.

### 3.6 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. Refer to Fire Protection Drawing FP0.1 for further installation instructions.
- C. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- J. Install alarm devices in piping systems.
- K. Hangers and Supports: Comply with NFPA 13 for hanger materials.
  - 1. Install sprinkler system piping according to NFPA 13.
  - 2. Pipe hangers and supports are to utilize galvanized hangers and zinc or cadmium plated steel rods and fasteners.
- L. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill wet-pipe sprinkler system piping with water.
- O. Exposed piping and fittings shall be left clean ready for field painting by others.



### 3.7 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

### 3.8 SPRINKLER APPLICATIONS

- A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
  - 1. Rooms without Ceilings: Upright sprinklers.
  - 2. Rooms with Suspended Ceilings: Recessed sprinklers.
  - 3. Wall Mounting: Sidewall sprinklers.
  - 4. Sprinkler Finishes:
    - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
    - b. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
    - c. Concealed Sprinklers: Rough brass or chrome plated, with chrome cover plate.

### 3.9 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in the center of acoustical ceiling panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

### 3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire department connections in vertical wall.
- B. Install ball drip valve at each check valve for fire department connection.

### 3.11 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Electrical Connections: Power wiring is specified in Division 26.
- G. Connect alarm devices to fire alarm.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.12 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

### 3.13 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - 3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
  - 4. Coordinate with fire alarm tests. Operate as required.
  - 5. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

END OF SECTION 211000

## SECTION 220000 - PLUMBING GENERAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 PLUMBING REQUIREMENTS

- A. The plumbing requirements are supplemental to the General Requirements of these Specifications. The Plumbing Sections shall apply to phases of the work specified, shown on the Drawings, or required to provide for the complete installation of Plumbing Systems for this project.
- B. The work shall include all items, articles, materials, operations and methods listed, mentioned, or scheduled in these specifications and the accompanying drawings. All material, equipment, and labor shall be furnished together with all incidental items required by good practice to provide the complete systems described.
- C. Examine and refer to all new Architectural, Civil, Structural, Electrical, Utility, Landscape, Communication, Fire Protection, and Mechanical drawings and specifications for construction conditions which may affect the plumbing work. Inspect the building site for verification of present conditions. Make proper provisions for these conditions in performance of the work and cost thereof.
- D. See general requirements for listed Alternate Bids and Bid Line Items. Note alternates listed and include any changes in work and price required to meet the requirements of the respective alternate.

#### 1.2 CODES AND STANDARDS

- A. All domestic water piping, valves, and equipment for potable water service shall comply with the Reduction of Lead in Drinking Water Act of 2011 which is enforced as of January 4, 2014.
- B. Work shall meet the requirements of the plans and specifications and shall not be less than the minimum requirements of applicable sections of the latest Codes and Standards of the following Organizations:
  - 1. American Gas Association (AGA)
  - 2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - 3. American Society of Mechanical Engineers (ASME)
  - 4. American Society of Plumbing Engineers (ASPE)
  - 5. American Water Works Association (AWWA)

6. National Electrical Code (NEC)
7. National Electrical Manufacturers Association (NEMA)
8. National Fire Protection Association (NFPA)
9. International Plumbing Code (IPC)
10. Occupational Safety & Health Act (OSHA)
11. Plastic Pipe Institute (PPI)
12. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
13. International Mechanical Code (IMC)
14. International Building Code (IBC)
15. International Fuel Gas Code (IFGC)
16. Requirements of the Serving Utility Company
17. Local and State Codes and Ordinances

### 1.3 FEES AND PERMITS

- A. The Plumbing Contractor shall pay all fees and arrange for all permits required for work done under his contract and under his supervision by subcontract.
- B. All usage contracts between the Owner and the serving utilities company, such as membership and usage charges or fees, etc., for the purpose of obtaining the services for the utility company shall be applied for and paid for by the Owner.

### 1.4 MATERIALS AND EQUIPMENT

- A. Manufacturer trade names and catalog numbers listed in each specification section and on the drawings are intended to indicate the quality of equipment or materials desired. Manufacturers not listed must receive prior approval prior to bidding. Written prior approval must be obtained from the Architect/Engineer ten (10) days prior to bid opening. Requests are to be submitted sufficiently ahead of the deadline to give ample time for examination. The items approved will be listed in an addendum and only this list of equipment will be accepted in lieu of specified products. Submittals must indicate the specific item or items to be furnished in lieu of those specified, together with complete technical and comparative data on specified items and proposed items.
  1. All Prior Approval Requests shall indicate the specific item or items to be furnished in lieu of those specified, together with complete technical and comparative data on specified items and proposed items. Each specification section lists the project's pre-approved manufacturers.
- B. Plumbing equipment may be installed with manufacturer's standard finish and color except where specific color, finish or choice is indicated. If the manufacturer has no standard finish, equipment shall have a prime coat and two finish coats of gray enamel.

- C. This Contractor shall be responsible for materials and equipment installed under this contract. Contractor shall also be responsible for the protection of materials and equipment of others from damage as a result of his work.
- D. Manufactured material and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by manufacturer unless herein specified to the contrary.
- E. This Contractor shall make the required arrangement with General Contractor for the introduction into the building of equipment too large to pass through finished openings.
- F. Store materials and equipment indoors at the job site or, if this is not possible, store on raised platforms and protect from the weather by means of waterproof covers. Coverings shall permit circulation of air around the materials to prevent condensation of moisture. Screen or cap openings in equipment to prevent the entry of vermin.

## 1.5 INTENT OF DRAWINGS

- A. The drawings are partly diagrammatic and do not necessarily show exact location of piping and ductwork unless specifically dimensioned. Riser and other diagrams are schematic and do not necessarily show the physical arrangement of the equipment. They shall not be used for obtaining lineal runs of piping or ductwork, nor shall they be used for shop drawings for piping and ductwork fabrication or ordering.
- B. The drawing plans, schematics, and diagrams indicate the general location and arrangements of piping and ducting systems. Install piping and ducting in the general areas shown on the plans. If significant routing deviations are necessary to improve the system routings or avoid unforeseen conditions contact the Engineer for review.
- C. Discrepancies shown on different plans, or between plans and actual field conditions shall be brought to the attention of the Engineer for resolution.

## 1.6 RESPONSIBILITY

- A. The Plumbing Contractor shall be responsible for the installation of a satisfactory and complete system in accordance with the intent of the drawing and specifications. Provide, at no extra cost, all incidental items required for completion of the work even though they are not specifically mentioned or indicated on the drawings or in the specifications.
- B. The drawings do not attempt to show complete details of the building construction which affect the plumbing system(s) installation; and reference is therefore required to the Architectural, Civil, Structural, Landscape, Mechanical, Fire Protection, Communication and Electrical drawings and specifications and to shop drawings of all

trades for additional details which affect the installation of the work covered under this Division of the Contract.

- C. Location of plumbing system components shall be checked for conflicts with openings, structural members and components of other systems having fixed locations. In the event of any conflicts, the Architect/Engineer shall be consulted and his decision shall govern. Necessary changes shall be made at the Contractor's expense.
- D. Determine, and be responsible for, the proper location and character of inserts for hangers, chases, sleeves, and other openings in the construction required for the work, and obtain this information well in advance of the construction progress so work will not be delayed.
- E. Final location of inserts, hangers, etc., required for each installation, must be coordinated with facilities required for other installations to prevent interference.
- F. Take extreme caution not to install work that connects to equipment until such time as complete Shop Drawings of such equipment have been approved by the Architect/Engineer. Any work installed by the Contractor, prior to approval of Shop Drawings, will be at the Contractor's risk.
- G. At all times during the performance of this Contract, properly protect work from damage and protect the Owner's property from injury or loss. Make good any damage, injury or loss, except such as may be directly due to errors in the Bidding Documents or caused by Agents or Employees of the Owner. Adequately protect adjacent property as provided by law and the Bidding Documents. Provide and maintain passageways, guard fences, lights and other facilities for protection required by Public Authority or Local conditions.
- H. The Contractor shall be responsible for damages due to the work of their Contractors, to the building or its contents, people, etc.

## 1.7 REVIEW

- A. All work and material is subject to review at any time by the Architect/Engineer or his representative. If the Architect/Engineer or his representative finds material that does not conform with these specifications or that is not properly installed or finished, correct the deficiencies in a manner satisfactory to the Architect/Engineer at the Contractor's expense.

## 1.8 WORKMANSHIP

### A. GENERAL

1. Work under this contract shall be performed by workmen skilled in the particular trade, including work necessary to properly complete the installation in a workmanlike manner to present a neat and finished appearance.

B. EXCAVATION AND BACKFILL

1. Provide all excavating and backfilling as required, with backfilling only after approval of the Architect. Backfill to be free of all debris and decayable matter.

C. CUTTING, PATCHING, AND FRAMING

1. Obtain Architect's/Engineer's approval before performing any cutting on structural members or patching of building surfaces. Any damage to the building or equipment by this Contractor shall be the responsibility of this Contractor and shall be repaired by skilled craftsmen of the trades involved at the Contractor's expense.
2. Chases, openings, sleeves, hangers, anchors, recesses, equipment pads, framing for equipment, provided by others only if so noted on the drawings. Otherwise, they will be provided by this Contractor for his work. Whether chases, etc., are provided by this Contractor or others, this Contractor is responsible for correct size and locations.

1.9 COORDINATION

- A. This Contractor shall plan his work to proceed with a minimum interference with other trades and it shall be his responsibility to inform the General Contractor of all openings required in the building structure for installation of work, and to provide sleeves as required. Dimensions of equipment installed and/or provided by others shall be checked in order that correct clearances and connections may be made.

1.10 CLEAN UP

- A. Keep the premises free from accumulation of waste material or rubbish caused by his work or employees.
- B. Upon completion of work, remove materials, scraps and debris relative to his work and leave the premises, including tunnels, crawl spaces, and pipe chases in clean and orderly condition. Remove all dirt and debris from the interior and exterior of all devices and equipment. After construction is completed, wash all mechanical equipment.

## 1.11 DUST PROTECTION

- A. Contractor will provide suitable dust protection for all existing areas prior to beginning of cutting or demolition. Contractor will obtain approval of partition from Owner before proceeding with work involved in these rooms.

## 1.12 TEMPORARY FACILITIES

### A. OFFICES

- 1. Contractor may provide a temporary office for himself and for the periodic use by the Architect\Engineer.

### B. REMOVAL

- 1. Contractor shall completely remove his temporary installations when no longer needed and the premises shall be completely clean, disinfected, patched, and refinished to match adjacent areas.

### C. LADDERS AND SCAFFOLDS

- 1. The Contractor shall provide their own ladders, scaffolds, etc. of substantial construction for access to their work in various portions of the building as may be required. When no longer needed, they shall be removed by the Contractor.

### D. PROTECTION DEVICES

- 1. The Contractor shall provide and maintain his own necessary barricades, fences, signal lights, etc., required by all governing authorities or shown on the drawings. When no longer needed, they shall be removed by the Contractor. The Contractor shall assume all responsibility for which the Owner may be held responsible because of lack of above items.

### E. TEMPORARY WATER

- 1. The Contractor shall provide all water required by his trade for construction. Temporary drinking water shall be provided by Contractor from a proven safe source dispensed by single service containers, until such time as the construction water outlet has been installed, disinfected, and approved for drinking purposes.

### F. TEMPORARY FIRE PROTECTION

- 1. The Contractor shall provide all necessary first-aid hand fire extinguishers for Class A, B, C and special hazards as may exist in his own work area only in



accordance with good and safe practice and as required by jurisdictional safety authority. The Contractor shall provide general area fire extinguishers only.

### 1.13 SHOP DRAWINGS

A. Provide manufacturer's literature and/or certified prints as soon as possible but within thirty (30) days after awarding of Contract, for items of materials, equipment, or systems where called for in specifications. Shop drawings and literature complete showing item used, size, dimensions, capacity, rough-in, etc., as required for complete check and installation. Manufacturer's literature showing more than one item shall be clearly marked as to which item is being furnished or it will be rejected and returned without review.

B. Shop Drawing (Submittals) Format:

1. Submittals shall be compiled and submitted in PDF format. The PDF method shall be presented as one (1) entire package per submittal section with each item in the respective submittal division clearly tagged.
2. The entire Division 22 shall be submitted in one (1) entire package, except as noted below. Submittal Binder Cover shall include the following:

#### SUBMITTAL BINDER COVER

Date:

Name of Project:

Name of Contracting Company:

Name of Contracting Company Project Contact Person:

Contracting Company Phone Number:

Branch of Work:

3. Each item submitted must be typewritten and clearly marked as follows for purposes of identification and record. Submittals not typewritten or not marked as described below will be rejected and returned without review.

SUBMITTAL BINDER DIVISION SECTIONS (as listed below in the

Schedule of Shop Drawings)

Specification Number and Title

Product Data Specification Number and Title (and Plan Code  
reference number where applicable)

4. At the contractor's option, specification sections with long-lead equipment can be submitted as individual submittal packages to allow independent and expedited reviews. Contractor shall coordinate with the Engineer prior to submitting packages.

C. Prior to Submittal Binder Submission:

1. Send the engineer a Submittal Binder Table of Contents for engineer review prior to formal submittal binder submission. The Table of Contents may be sent via

facsimile or email methods. Once the Submittal Binder Table of Contents is approved by the engineer then the contractor shall submit the complete Submittal Binder.

2. Each submittal shall be thoroughly checked by the Contractor for compliance with the Contract Document requirements, accuracy of dimensions, relationship to the work of other trades, and conformance with sound, safe practices as to erection and installation. Each submittal shall then bear a stamp evidencing such checking and shall show corrections made, if any. Submittals requiring extensive corrections shall be revised before submission. Each submittal not stamped and signed by the Contractor evidencing such checking will be rejected and returned without review.
- D. All submittals will be examined when submitted in proper form for compliance. Such review shall not relieve the Contractor of responsibility for errors, for deviation from the contract Documents, nor for violation of sound safety practices.
  - E. The Contractor shall keep in the field office one print of each submittal which has been reviewed and stamped by the Architect or Engineer.
  - F. Submittals will be required for each product item as identified and listed in the Submittal paragraph for each respective specification section listed in the Schedule of Shop Drawings listed below in paragraph H.
  - G. Submittals which are incomplete relative to quality requirements, capacity, engineering data, dimensional data or detailed list of specialty or control equipment will be rejected. Lists shall include descriptive coding as specified or shown on drawings.
  - H. The engineer will perform shop drawing review of each item; however, subsequent review of items previously rejected will be billed to the contractor at a rate of \$195 per hour.
  - I. SCHEDULE OF SHOP DRAWINGS.
    1. In order of specification section.
  - J. Should the contractor be required to re-submit, then the entire submittal package shall be re-submitted, unless prior permission is received from the engineer for some other method.

#### 1.14 OPERATION AND MAINTENANCE MANUALS

- A. At the time orders are placed for any item of equipment requiring service or operating maintenance, the Contractor shall request the manufacturer furnish three (3) hard copies and one (1) electronic PDF copy of OPERATION AND MAINTENANCE INSTRUCTIONS for each piece of equipment. These shall be included in the brochure of equipment.

- B. Operation and Maintenance manuals shall contain letter of one (1) year warranty with the start date listed.
- C. Operation and Maintenance manuals shall contain all startup reports associated with plumbing equipment.
- D. Operation and Maintenance manuals shall contain the domestic water disinfection reports as outlined in specification section 221116.
- E. Operation and Maintenance manuals shall contain the final hot water recirculation system test and balance reports for future reference.
- F. Owner signed, Owner Training documents shall be included in the Operation and Maintenance manuals.
- G. Refer to individual specification sections which outline additional devices, fixtures, and equipment which require Operation and Maintenance data to be included within the manuals.

#### 1.15 BROCHURE OF EQUIPMENT

- A. Upon completion of work, prepare three copies of "Brochure of Equipment" containing data pertinent to equipment and systems on job. Binders containing materials shall be one or more three ring binders of sufficient number to hold all literature. Contained in binders shall be: Installation, maintenance, and operating instructions for each piece of equipment; parts lists; wiring diagrams; one copy of each shop drawing and literature submittal; record drawings, etc.
- B. All literature shall be clean, unused and filed under divider headings corresponding to the specifications.
- C. These brochures shall be submitted to the Architect/Engineer and approved by him before authorization of final payment.

#### 1.16 AS-BUILT DRAWINGS

- A. The Contractor shall furnish to the Owner and Architect/Engineer a marked print showing the location of all concealed or underground pipe or conduit runs and other equipment installed other than as shown on the drawings. Dimension underground lines from established building lines. Indicate all installed pull boxes in conduit runs.
- B. The Contractor shall furnish to the Architect/Engineer a marked print showing the location of all mechanical equipment, plumbing fixtures, piping, etc. The location of

any item which deviates from the bid documents shall be accurately drawn and dimensioned.

- C. The location of all maintenance related items such as isolation valves, thermostatic mixing valves, balance valves, etc., shall be highlighted on as built drawing.
- D. All underground piping shall be dimensioned from nearest column and/or exterior walls. The location of all maintenance related items such as access doors, isolation valves, filters, etc., shall be highlighted on as built drawing.
- E. One (1) complete full size paper copy and a scanned (in color) PDF electronic copy of the as-built drawings shall be provided.

#### 1.17 PLACING SYSTEMS IN OPERATION

- A. At the completion of the work and at such time as the Owner shall direct, prior to final acceptance, the Contractor performing this work shall put into satisfactory operation the various systems installed under the specifications. At no additional cost to the Owner, furnish the services of a person completely familiar with the installations performed under this specification, to instruct the Owner's operating personnel in the proper operation and servicing of the equipment and systems. These services shall be available for a period of no less than one (1) day.
  - 1. Once completed, an Owner training document shall be signed by the Contractor and the Owner and included within the O-M Manuals.

#### 1.18 WARRANTY

- A. The Contractor shall guarantee that all materials and labor installed are new and of first quality and that any material or labor found defective shall be replaced without cost to the Owner within one (1) year after substantial completion of the Contract or one (1) full season of heating and cooling operation, whichever is the greater. The guarantee shall list the date of the beginning of the one (1) year period, which shall be the date that the Substantial Completion Certificate is issued.
- B. Any damage to the building, caused by defective work or material of the Contractor within the above-mentioned period, shall be satisfactorily repaired without cost to the Owner.
- C. The guarantee does not include maintenance of equipment. The Owner shall accept full responsibility for proper operation and maintenance of equipment immediately upon substantial completion and occupancy of the building.

- D. Final acceptance by the Owner will not occur until all operating instructions are mounted in Equipment Rooms and Operating Personnel thoroughly indoctrinated in the operation of all mechanical equipment by the Contractor.
- E. Any equipment, including domestic hot water heater, re-circulating pump, plumbing fixtures, etc., used for temporary heat, shall be brought up to a new condition before final acceptance by the Owner and shall be guaranteed by the Contractor as new equipment.
- F. During the warranty period, if system or equipment issues arise, the Contractor shall submit a warranty report to the Architect/Engineer identifying the issue and what was done to correct the issue. The warranty report shall identify the date the issue was discovered, when the issue was resolved, and the key personal involved in resolving the issue.

END OF SECTION 220000

## SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Sleeves.
  - 5. Escutcheons.
  - 6. Grout.
  - 7. Equipment installation requirements common to equipment sections.
  - 8. Concrete bases.
  - 9. Supports and anchorages.

#### 1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### 1.3 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT MANUFACTURERS

- A. Equipment in each of the following categories shall be of one manufacture or available through one manufacture, or vendor, for each category to facilitate ease of maintenance for the Owner. Refer to Division 23 for similar products.
  - 1. Thermometers.
  - 2. Pressure Gauges
  - 3. Check Valves
  - 4. Ball Valves
  - 5. Butterfly Valves
  - 6. Balancing Valves
  - 7. Dielectric Unions
  - 8. Strainers

### 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is 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 or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D 2235.
  - 2. CPVC Piping: ASTM F 493.
  - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 4. PVC to ABS Piping Transition: ASTM D 3138.

## 2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

## 2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.



- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated.

## 2.8 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, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 CEILING ACCESS PANELS

- A. Provide ceiling access panels in hard lid ceilings as required to provide access to equipment, piping, piping accessories, ductwork, duct accessories etc. requiring access. Refer to Division 08 - ACCESS DOORS AND FRAMES for ceiling access panel requirements. Coordinate access panel locations with the Architect prior to installation.

### 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 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 Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.

- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 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. 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 complying with ASTM B 32.
- E. 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.
- F. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 4. 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.
  - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
  - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

### 3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### 3.6 CONCRETE BASES

- A. 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 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 centers around the full perimeter of the 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, 28-day compressive-strength concrete and reinforcement.

### 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

### 3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### 3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 220500

## SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 LIQUID-IN-GLASS THERMOMETERS

##### A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Miljoco Corporation.
  - b. Terice, H. O. Co.
  - c. Winters Instruments - U.S.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 THERMOWELLS

### A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.3 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Miljoco Corporation.
  - d. Terrice, H. O. Co.
  - e. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-inch minimum nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.



- 10. Ring: Stainless steel.
- 11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

## 2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install thermometers in the following locations:
  - 1. Where shown on the Drawings.
- I. Install pressure gages in the following locations:
  - 1. Where shown on the Drawings.
- J. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

- K. Adjust faces of meters and gages to proper angle for best visibility.

### 3.2 THERMOMETER SCHEDULE

- A. Thermometers shall be the following:

- 1. Industrial-style, liquid-in-glass type.

- B. Thermometer stems shall be of length to match thermowell insertion length.

### 3.3 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 20 to 200 deg F.

- B. Scale Range for Domestic Hot-Water Piping: 20 to 200 deg F.

### 3.4 PRESSURE-GAGE SCHEDULE

- A. Pressure gages shall be the following:

- 1. Liquid-filled, direct-mounted, metal case.

### 3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION 220519

## SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Bronze swing check valves.
3. Bronze spring check valves.
4. Butterfly valves.
5. Cast iron wafer check valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

#### 1.2 SUBMITTALS

A. Product Data: For each type of valve indicated.

B. Operation and Maintenance data.

#### 1.3 QUALITY ASSURANCE

A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

C. All piping, valves, and equipment for domestic water service shall comply with the Reduction of Lead in Drinking Water Act of 2011 which is being enforced as of January 4, 2014.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  - 1. Handwheel: For valves other than quarter-turn types.
  - 2. Handlever: For quarter-turn valves NPS 6 and smaller.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
  - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 2. Butterfly valves: With extended neck.
- F. Valve-End Connections:
  - 1. Solder Joint: With sockets according to ASME B16.18.
  - 2. Flanged: With flanges according to ASME B16.1 for iron valves
  - 3. Threaded: With threads according to ASME B1.20.1.
  - 4. Copper Pressure-Seal-Joint according to ASME B16/51.

### 2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim & Threaded Ends:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Nibco.
    - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Model: Watts - Series LFB6080G2 Threaded; Nibco – T-585-80-LF Threaded
    - b. Standard: MSS SP-110.
    - c. SWP Rating: 150 psig.
    - d. CWP Rating: 600 psig.
    - e. Body Design: Two piece.

- f. Body Material: Bronze.
  - g. Ends: Threaded.
  - h. Seats: PTFE or TFE.
  - i. Stem: Bronze.
  - j. Ball: Chrome-plated brass.
  - k. Port: Full.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim with Pressure-Seal-Joint Ends:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Viega.
    - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - c. Nibco
  - 2. Description:
    - a. Model: Viega – Model 2971.1ZL, Watts – Series LFFBV-3-Press, Nibco - PC-585-80-LF
    - b. Standard: MSS SP-110.
    - c. CWP Rating: 200 psig.
    - d. Body Design: Two piece.
    - e. Body Material: Bronze.
    - f. Ends: Copper Pressure-Seal-Joint
    - g. Seats: PTFE or TFE.
    - h. Stem: Bronze.
    - i. Ball: Chrome-plated brass.
    - j. Port: Full.

## 2.3 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - b. Nibco
  - 2. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: Bronze. (Lead Free)

## 2.4 BRONZE SPRING CHECK VALVES

### A. Class 125, Bronze Spring Check Valves with Bronze Disc & Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Body: Lead free cast copper silicon alloy.
  - b. Guide Bushing: Stainless steel.
  - c. Check: Lead free copper silicon alloy.
  - d. Spring: Stainless Steel.
  - e. Seat: PTFE.
  - f. Ends: Threaded ends.

## 2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

### A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Pentair Valves & Controls.
  - b. Nibco
  - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Model: Pentair - Keystone Series 222, Nibco – LD-2000, Watts – BF-03-M2 Lug
  - b. Standard: MSS SP-67, Type I.
  - c. CWP Rating: 150 psig.
  - d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - e. Body Material: Cast Iron ASTM A126 Class B.
  - f. Seat: EPDM.
  - g. Stem: One- or two-piece stainless steel.
  - h. Disc: Aluminum bronze.

## 2.6 CAST IRON WAFER CHECK VALVES

### A. Class 125, Cast Iron Wafer Check Valves with Aluminum Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

## 2. Description:

- a. Standard: API 594
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B A126, Cast Iron (Lead Free)
- e. Ends: Install between Class 125 or 150 Flanges
- f. Spring: Stainless Steel
- g. Seat: EPDM
- h. Disc: Aluminum Bronze (Lead Free)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

F. Valve Handle:

1. Contractor shall not be permitted to modify the valve handle configuration from the manufacturer's configuration.
2. Contractor shall position valves to permit full use and access to the valve handles.

### 3.3 ADJUSTING

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

### 3.4 IDENTIFICATION

- A. Provide and install valve tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar rough-in connections of end-use fixtures and units. List tagged valves in a valve schedule. Refer to Division 22 section "Identification for Plumbing Piping and Equipment" for valve tag requirements.

### 3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly.
2. Pump-Discharge Check Valves:
  - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

- C. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

### 3.6 DOMESTIC HOT, HOT WATER RECIRCULATION, AND COLD-WATER VALVE SCHEDULE (SOFT AND NON-SOFTENED WATER LINES)

- A. Pipe NPS 2 and Smaller:

1. Ball Valves: Provide with threaded ends or Copper Pressure-Seal-Joint ends



2. Bronze Swing Check Valves: Provide with threaded ends.
3. Bronze Spring Check Valves where shown to be installed on the drawings:  
Provide with threaded ends.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves.
2. Cast Iron Wafer Check Valves.

END OF SECTION 220523

## SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

#### 1.2 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 1.4 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Insulation protection shields.

#### 1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
  - 1. B-Line Systems, Inc.; a division of Cooper Industries.
  - 2. ERICO/Michigan Hanger Co.
  - 3. Grinnell Corp.
  - 4. National Pipe Hanger Corporation.
  - 5. PHD Manufacturing, Inc.
  - 6. Piping Technology & Products, Inc.
  - 7. Tolco Inc.
  - 8. Other manufactures meeting the specification requirements.
- C. Galvanized, Metallic Coatings: Hot dipped galvanized, electro-galvanized, or zinc plated steel.

### 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.
- B. Coatings: Hot dipped galvanized, electro-galvanized or zinc plated steel.

### 2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
  2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
  3. Power-Strut Div.; Tyco International, Ltd.
  4. Tolco Inc.
  5. Unistrut Corp.; Tyco International, Ltd.
  6. Other manufactures meeting the specification requirements.
- C. Galvanized, Metallic Coatings: Hot dipped galvanized, electro-galvanized, or zinc plated steel.

## 2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
1. ERICO/Michigan Hanger Co.
  2. Pipe Shields, Inc.
  3. Rilco Manufacturing Company, Inc.
  4. Value Engineered Products, Inc.
  5. Other manufactures meeting the specification requirements.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
1. Insert thickness shall match insulation thickness.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
1. Insert thickness shall match insulation thickness.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Empire Industries, Inc.
- c. Hilti, Inc.
- d. ITW Ramset/Red Head.
- e. MKT Fastening, LLC.
- f. Powers Fasteners.
- g. Other manufacture meeting the specification requirements.

## 2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.
- B. Coatings: Hot dipped galvanized, electro-galvanized or zinc plated steel.

## 2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
  3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
  4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated and insulated stationary pipes, NPS 1/2 to NPS 1 1/2.
  5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
  7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
- F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.

7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
  - a. Light (MSS Type 31): 750 lb.
  - b. Medium (MSS Type 32): 1500 lb.
  - c. Heavy (MSS Type 33): 3000 lb.
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- J. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- K. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- L. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
  1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
  - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
  - 1. Clamped piping:
    - a. Piping 1-1/2" and smaller: use protection shields. Shields shall span an arc of 180 degrees.
    - b. Piping 2" and larger: use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
    - d. Do not penetrate the vapor barrier on insulated piping.
  - 2. Hanger Supported piping:



- a. Piping 1-1/2" and smaller: use protection shields. Shields shall span an arc of 180 degrees.
  - b. Piping 2" and larger: use thermal-hanger shield insert with clamp sized to match OD of insert.
  - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping
- 3. Protection Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
  - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
- 4. Piping Operating below Ambient Air Temperature: Insulation shall be continuous through the clamped and hanger supported piping.
- 5. Piping Operating above Ambient Air Temperature: Clamp or Hanger may project through the insulation.
- 6. Insulation shall be continuous through the clamped and hanger supported piping.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Contractor shall verify all pipe hanger locking nuts have been re-tightened after the pipe insulation has been installed through each pipe hanger. Contractor shall thoroughly review and re-tighten all locking nuts on all pipe hangers after insulation has been installed.

### 3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

## SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.
4. Emergency equipment identification signs.

#### 1.2 SUBMITTAL

##### A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

##### A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

##### B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules).

## 2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe with or without a fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

## 2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on a 8-1/2 x 11-inch bonded paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, close, or modulating), and variations for identification. Mark valves for emergency shut-off and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.

- B. Locate equipment labels where accessible and visible.

### 3.3 EMERGENCY EQUIPMENT IDENTIFICATION SIGNS

- A. Sign to be provided with the emergency fixture.
- B. Fasteners: Stainless-steel rivets or self-tapping screws.
- C. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- D. Locate at the emergency fixture in a visible location per ANSI requirements.

### 3.4 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:
  - 1. Domestic Water Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.
  - 2. Above Floor Sanitary Waste and Vent, Storm Drain Primary and Secondary, and Condensate Drainage Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.

### 3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar rough-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - a. Domestic Water Valves: 1-1/2 inch round.
  - 2. Valve-Tag Color:
    - a. Cold and Hot Water: Natural
    - b. Letter Color: stamped only allowed.

END OF SECTION 220553

## SECTION 220700 - PLUMBING INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
  - a. Flexible elastomeric.
  - b. Mineral fiber.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied jackets.
8. Tapes.
9. Securements.
10. Corner angles.

B. Related Sections include the following:

1. Division 23 Section "HVAC Insulation."

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control reports.

#### 1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

- B. Insulation materials that have become wet or contaminated shall not be used.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Micro-Lok HP.
  - 2. All piping shall be insulated with a pre-formed fiber glass pipe insulation, complying with ASTM C547, Class 3 (to 850°F), rigid, molded, noncombustible (plain) or limited combustibility (jacketed) pipe insulation.
  - 3. Thermal Conductivity ("k"): 0.23 Btu • in/ (hr • ft<sup>2</sup> • °F) at 75°F mean temperature per ASTM C518.
  - 4. Maximum Service Temperature: 850°F.
  - 5. Rated to a maximum 25/50 FS/SD per ASTM E84.



6. All-Service vapor retarder Jacket (ASJ): A white, kraft paper or poly exterior, reinforced with a glass fiber yarn and bonded to an aluminum foil with self-sealing longitudinal closure laps (SSL) and butt strips.
7. Install Micro-Lok HP insulation at the thickness required to prevent condensation as indicated in project drawing.
8. Micro-Lok HP is UL listed and labeled over plastic pipes for air plenum applications when used at 1.0" thickness or greater.
9. Material shall be limited-combustible as defined in NFPA 90A with a potential heat value not exceeding 3,500 btu/lb when tested in accordance with NFPA 259.
10. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Insulco, Division of MFS, Inc.; SmoothKote.
    - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
    - c. Rock Wool Manufacturing Company; Delta One Shot.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  1. Products: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA Inc.; AeroSeal.
    - b. Armacell LCC; 520 Adhesive.
    - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    - d. RBX Corporation; Rubatex Contact Adhesive.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Chemical Company (The); 739, Dow Silicone.
    - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Speedline Corporation; Speedline Vinyl Adhesive.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-35.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-10.
    - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - d. Marathon Industries, Inc.; 550.
    - e. Mon-Eco Industries, Inc.; 55-50.
    - f. Vimasco Corporation; WC-1/WC-5.
  2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 200 deg F.
  4. Solids Content: 63 percent by volume and 73 percent by weight.
  5. Color: White.

## 2.5 SEALANTS

- A. Joint Sealants:
- B. Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-76-8.
    - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    - c. Marathon Industries, Inc.; 405.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Vimasco Corporation; 750.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: Aluminum.
  6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-76.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

## 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
  5. Factory-fabricated tank heads and tank side panels.
- C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  1. Sheet and roll stock ready for shop or field sizing.
  2. Finish and thickness are indicated in field-applied jacket schedules.
  3. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper 2.5-mil thick polysurlyn.
  4. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as the jacket.
    - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.

- d. Flange and union covers.
- e. End caps.
- f. Beveled collars.
- g. Valve covers.
- h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

## 2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
- b. Compac Corp.; 104 and 105.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
- d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.

3. Thickness: 11.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
- b. Compac Corp.; 130.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
- d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.

3. Thickness: 6 mils.

4. Adhesion: 64 ounces force/inch in width.

5. Elongation: 500 percent.

6. Tensile Strength: 18 lbf/inch in width.

C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
- b. Compac Corp.; 110 and 111.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
- d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

## 2.9 SECUREMENTS

- A. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- B. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.
  1. Products: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.
    - b. RPR Products, Inc.

## 2.10 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

## 2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Engineered Brass Company.
    - b. Insul-Tect Products Co.
    - c. McGuire Manufacturing.
    - d. Plumberex Specialty Products, Inc.
    - e. Truebro.
    - f. Zurn Industries, LLC.
  2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
    - a. Model: TRUEBRO Undersink Pipe Guard #82525 Item #15W937

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
  2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Manholes.
  5. Handholes.
  6. Cleanouts.



### 3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
- F. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies.

### 3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.6 MINERAL-FIBER INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. All pipe insulation installed in mechanical rooms shall be fitted with PVC jackets.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
  - 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Soft and Non-Soft Cold, Hot, and Recirculated Hot Water Piping 2" and less: Insulation shall be the following:
  1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Soft and Non-Soft Cold, Hot, and Recirculation Hot Water Piping 2-1/2" and larger: Insulation shall be the following:
  1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 1/2" inch thick.
- C. Above Ground Condensate Drainage Piping: Insulation shall be the following:
  1. UL listed and labeled to cover plastic piping in return air plenums:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Above Ground Storm Drain Primary and Secondary Overflow Piping: Insulation shall be the following:
  1. UL listed and labeled to cover plastic piping in return air plenums:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
- E. Above Ground Acid Waste, Avid Vent, Sanitary Waste and Vent Piping: Insulation shall be the following:
  1. UL listed and labeled to cover plastic piping in return air plenums:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- F. Domestic Hot Water Heater Combustion Air Piping:
  1. Flexible Elastomeric: 1-inch thick.

### 3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Condensate Drain Piping serving the kitchen MUA: Insulation shall be the following:
  1. Flexible Elastomeric: 1-inch thick.
  2. Piping shall be fitted with electrical heat tape, coordinate with the EC.

### 3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. 45 and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints:
  1. PVC Jacket, corner angles with a white finish.
  2. Note: Exposed piping does not require field applied jacketing, only the fittings noted above.

- B. All pipe insulation installed in mechanical rooms shall be fitted with PVC jackets.
- C. ADA/ANSI exposed fixture P-trap and supply covers:
  - 1. Protective Shielding Pipe Covers

### 3.13 OUTDOOR PIPING, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Exterior condensate drain pipe insulation shall be jacketed with aluminum jacketing with seams sealed water tight. Coordinate installation with the electrical contractor and the respective heat tape to serve the exterior condensate drain piping.
- C. Condensate Drain Piping, Exposed:
  - 1. Aluminum, stucco embossed: 0.024 thick.

### 3.14 EXTRA MATERIALS

- A. Provide the following extra materials to the Owner at substantial completion:
  - 1. Pipe Insulation – 20-feet of extra pipe insulation, per each size and thickness of size pipe for 6" and smaller piping.

END OF SECTION 220700

## SECTION 221116 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.
3. Transition fittings.

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Certification that products comply with NSF 61 and NSF 372.

B. Field quality-control reports.

1. Include reports within the Operation and Maintenance Manuals upon completion.

#### 1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61 for potable domestic water piping and components.

D. All piping, valves, and equipment for domestic water service shall comply with the Reduction of Lead in Drinking Water Act of 2011 which will be enforced January 4, 2014.



## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

### 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
  - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
  - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
  - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
  - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
  - 5. Copper Pressure-Seal-Joint Fittings:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Viega; Plumbing and Heating Systems.
      - 2) Nibco.
    - b. NPS 1/2 and Larger: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    - c. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
    - d. Housing: Copper.
    - e. O-Rings and Pipe Stops: EPDM.
    - f. Tools: Manufacturer's special tools.
    - g. Minimum 200 psig working-pressure rating at 250 deg F.

### 2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. 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. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
    - a. Gaskets: AWWA C111, rubber.
  - 2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
    - a. Gaskets: AWWA C111, rubber

## 2.4 PRE-INSULATED PEX TUBE AND FITTINGS WITH JACKET

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. REHAU.
2. Uponor.
3. Viega LLC.
4. Watts Radiant; A WATTS Brand.

B. Piping:

1. All pipe shall be crosslinked polyethylene manufactured using the high-pressure peroxide method of crosslinking (known as PEXa). Pipe shall conform and be third-party certified to AWWA C904, ASTM F876, CSA B137.5, NSF/ANSI 14 and NSF/ANSI 61.
2. Pipe shall be rated for continuous operation of 100 psi gauge pressure at 180°F temperature and 160 psi gauge pressure at 73.4°F temperature as defined in AWWA C904.
3. Pipe shall be rated for continuous operation at 200 psi gauge pressure at 73°F temperature when evaluated using a 0.63 design factor.
4. Pipe shall be listed by PPI to standard TR-3 as Standard Grade,
5. Pipe to be tested for resistance to hot chlorinated water in accordance with ASTM F2023. Pipe to have a minimum Class 3 chlorine resistance rating when evaluated to F876 and tested in accordance to F2023.
6. PEXa pipe shall be listed with a material designation code of "3306" per the ASTM F876 standard and PPI TR-3.
7. Pipe to have a co-extruded UV Shield made from UV-resistant polyethylene, color blue. Pipe to have minimum recommended UV exposure time of 12 months when tested in accordance with ASTM F2657 and evaluated in accordance with ASTM F876.
8. Pipe shall be manufactured in a facility whose quality management system is certified according to ISO 9001.
9. Bend Radius: The minimum bend radius for cold bending of PEXa pipe shall be not more than five (5) times the outside diameter.

C. Fittings

1. Cold-expansion compression-sleeve fittings shall be in accordance with ASTM F2080.

D. Markings

1. Pipe shall carry the following markings every three (3) feet:
  - a. Manufacturer's name and trademark, nominal size, PEXa 3306 (material designation code) SDR9 (standard dimension ratio), POTABLE TUBING, AWWA C904, ASTM F876/ F2023 / F2080, CSA B137.5, NSF-pw-g, U.P.

Code 160psi/73°F 100psi/180°F 200psi/73°F at 0.63 Design Factor, manufacturing date and footage mark.

## 2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Solvent Cements for CPVC Piping: ASTM F 493.

## 2.6 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves and drain valves.

## 2.7 TRANSITION FITTINGS

- A. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- B. Sleeve-Type Transition Coupling: AWWA C219.
- C. Plastic-to-Metal Transition Fittings:
  - 1. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.
- D. Plastic-to-Metal Transition Unions:
  - 1. Description: PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

## 2.8 DIELECTRIC FITTINGS

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for dielectric fittings.

## 2.9 SLEEVES AND SLEEVE SEALS

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for sleeve and sleeve seals.

## 2.10 ESCUTCHEONS

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for escutcheons.

## 2.11 GROUT

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for grout.

# PART 3 - EXECUTION

## 3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

- F. Install domestic water piping level and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Do not install piping directly above electrical, IT or temperature control panels or equipment.
- R. Install pressure gages where shown on the drawings. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- S. Install thermostats where shown on the drawings. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermostats.
- T. Install thermometers where shown on the drawings. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

### 3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. 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.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Socket Fusion Joints: Join fittings with tools recommended by fitting manufacturer.
- H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
  - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
  - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch as shown on the drawings. Set balancing valves partly open to restrict but not stop flow at the specified flow rates shown on the drawings. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

### 3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. NPS 2 and Larger: Sleeve-type coupling.

### 3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

### 3.6 WATER METER INSTALLATION

- A. Rough-in domestic water piping for water meter installation, and install water meters according to utility company's requirements.
- B. Water meter on the domestic water riser assembly will be furnished by the utility company.
- C. Install water meters according to AWWA M6, and utility company's requirements.

### 3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis or steel band hangers as permitted in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
  3. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
  6. NPS 6: 10 feet with 5/8-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

### 3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.



3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### 3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors. Escutcheons shall have polished chrome plated finish in all finished spaces.

### 3.10 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
  1. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
    - a. Extend sleeves 2 inches above finished floor level.
    - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is

specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

2. Sleeves for Piping Passing through Exterior Concrete Walls:

- a. Steel pipe sleeves for pipes smaller than NPS 6.
- b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

### 3.11 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.12 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

### 3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
  1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
  2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

- b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
  - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
  - 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.14 CLEANING

- A. Clean and disinfect potable and non-potable domestic water piping as follows:
  - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

- 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

### 3.15 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water, building-service piping, NPS 8, shall be the following:
1. Combo domestic water / fire sprinkler water main will be used to serve the building.
    - a. Push-on-joint, ductile-iron pipe; standard- or compact- pattern push-on-joint fittings; and gasketed joints.
- D. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
  2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- E. Aboveground domestic water piping, NPS 1 and smaller, branch main only, located within walls that do not communicate with the return air plenum:
1. Pre-Insulated and jacketed PEX-type A piping with carrier pipe, NSF-61 compliant.
- F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

### 3.16 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  1. Shutoff Duty: Use ball for piping NPS 2 and smaller. Use lug style butterfly valves for piping NPS 2-1/2 and larger.
  2. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
  3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

## SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Balancing valves.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Temperature-actuated water mixing valves.
5. Strainers.
6. Hose bibbs.
7. Wall hydrants.
8. Drain valves.
9. Water hammer arresters.
10. Trap-seal trap guards.
11. Domestic Hot Water Recirculation Pumps.
12. Washer outlet boxes.
13. Ice maker outlet boxes.
14. Flow splitter.
15. Roof Hydrants.

#### 1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61 for potable domestic water piping and components. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and

NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

## PART 2 - PRODUCTS

### 2.1 BACKFLOW PREVENTERS

#### A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Watts Industries, Inc.; Water Products Div.
2. Model:
  - a. 2 1/2" and larger: Series 957NRS
  - b. 2" and less: Series LF909QT
3. Standard: ASSE 1013.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
6. Size: As listed on the drawings.
7. Design Flow Rate: As listed on the drawings.
8. Body: Bronze for NPS 4 and smaller. (Lead Free).
9. End Connections: Threaded for NPS 4 and smaller.
10. Configuration: Designed for horizontal, straight through flow.
11. Accessories:
  - a. Valves: Ball type with threaded ends on inlet and outlet.
  - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

#### B. Double-Check Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Watts Industries, Inc.; Water Products Div.
2. Model:
  - a. 2" and less: LF007QTS
  - b. 2-1/2" and greater: 757NRS
3. Standard: ASSE 1015.
4. Operation: Continuous-pressure applications, unless otherwise indicated.
5. Pressure Loss: 7 psig maximum, through middle 1/3 of flow range.
6. Size: As listed on the drawings.
7. Design Flow Rate: As listed on the drawings.

8. Body: Bronze for NPS 2 and smaller; 304 (Schedule 40) Stainless steel housing and sleeve for NPS 2-1/2 and larger. (Lead Free).
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
10. Configuration: Designed for horizontal, straight through flow.
11. Accessories:
  - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; non-rising stem gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

## 2.2 WATER PRESSURE-REDUCING VALVES

### A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: As listed on the drawings.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger. (Lead Free)
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

## 2.3 BALANCING VALVES

### A. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong International, Inc.
  - b. Flo Fab Inc.
  - c. ITT Industries: Bell & Gossett Div.
  - d. NIBCO INC.
  - e. Taco, Inc.
  - f. Watts Industries, Inc. Water Products Div.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Brass or bronze (Lead Free).
4. Size: Same as connected piping.
5. End Connections: Threaded.



## 2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

### A. Water-Temperature Limiting Devices:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Leonard Valve Company
  - b. Powers; a Watts Industries Co.
  - c. Watts Industries, Inc. Water Products Div.
2. Description: As outlined on the plumbing drawings.
3. Accessories: Provide and install the "Mixing Valve Connector" from the TMV to the sink faucet.
  - a. Manufacture- Leonard Water Temperature Controls.

## 2.5 STRAINERS FOR DOMESTIC WATER PIPING

### A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger. (Lead Free)
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
  - a. Strainers NPS 2 and Smaller: 0.020 inch.
  - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
6. Drain: Factory-installed, hose-end drain valve.

## 2.6 HOT & COLD WATER OR COLD WATER ONLY HOSE BIBBS

### A. Hot & Cold water hose bibbs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn.
  - b. Jay R Smith
  - c. Zurn.
  - d. Woodford Manufacturing Company.
2. Description: As outlined on the plumbing drawings.

## 2.7 WALL HYDRANTS

### A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Woodford Manufacturing Company.
  - b. Jay R Smith
  - c. Zurn.
  - d. Acorn.
2. Description: As outlined on the plumbing drawings.

## 2.8 DRAIN VALVES

### A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.9 WATER HAMMER ARRESTERS

### A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company.
  - b. PPP Inc.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - e. Watts Drainage Products Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

## 2.10 TRAP-SEAL TRAP GUARDS

### A. Passive, Trap-Seal Trap Guard

1. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Rectorseal, Inc.
2. Standard: ASME A112.6.3, NSF/ANSI 14.
3. Material: Smooth, soft, flexible, elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom.
4. Allows wastewater to open and adequately discharge floor drain through its interior.
5. Closes and returns to original molded shape after wastewater discharge is complete.
6. Throat: match drain outlet pipe size.
7. Match drain style installed.
8. Trap guards shall be approved for use with grease laden waste.

## 2.11 DOMESTIC HOT WATER RECIRCULATION PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Grundfos
  2. Taco, Inc.
- B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, centrifugal pumps.
- C. Pump Construction:
  1. Casing: Stainless Steel or brass (lead free)
  2. Stator Housing: Steel.
  3. Cartridge: Stainless Steel.
  4. Impeller: Non-Metallic.
  5. Shaft: Ceramic.
  6. Bearings: Carbon.
  7. O-Ring-Flange Gasket: EPDM.
- D. Motor: Single speed, permanently lubricated ball bearings.
- E. Capacities and Characteristics: Refer to the Plumbing Drawings.

## 2.12 ROOF HYDRANTS

- A. Nonfreeze Roof Hydrants:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc
    - b. Watts Drainage Products Inc
    - c. Woodford Manufacturing Company.

- B. Description: As outlined on the plumbing drawings.

## 2.13 WASHING MACHINE WALL BOXES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Guy Gray – Water-Tite
  - 2. Oatey
  - 3. Sioux Chief
- B. Description: As outlined on the plumbing drawings.

## 2.14 ICE MACHINE WATER SUPPLY BOXES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Guy Gray – Water-Tite
  - 2. Oatey
  - 3. Sioux Chief
- B. Description: As outlined on the plumbing drawings.

## 2.15 THERMOSTATIC FLOW SPLITTER / BALANCE VALVE

- A. Self-actuating thermostatic balancing valve designed to automatically regulate domestic hot water return flow based on temperature.
- B. Provide flow splitting capability where multiple return branches connect to a common return header.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Kemper Thermostatic Balancing Valve / Flow Splitter (e.g., Kemper Multitherm or equivalent).
- D. Construction:
  - 1. Body: Dezincification-resistant (DZR) brass or bronze.
  - 2. Internal Components: Corrosion-resistant materials suitable for potable water.
  - 3. Seals: EPDM or manufacturer standard suitable for domestic hot water.
- E. Performance:
  - 1. Temperature Control Range: 95°F to 140°F (adjustable).
  - 2. Accuracy:  $\pm 3^{\circ}\text{F}$  (typical).
  - 3. Pressure Rating: Minimum 150 psi working pressure.

4. Maximum Operating Temperature: 180°F.

F. Features:

1. Automatic thermal regulation of return flow.
2. Integrated check valve (where indicated).
3. Isolation capability with optional shutoff.
4. Memory stop for temperature setting.
5. Test ports for commissioning and verification.
6. Capability to function as a flow splitter for multiple branch circuits.

G. Optional Accessories:

1. As listed on the plumbing drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
  2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
  3. Do not install bypass piping around backflow preventers.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install thermometers and water regulators if specified.
  2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- E. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- F. Install water hammer arresters in water piping according to PDI-WH 201.
- G. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

- H. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Intermediate atmospheric-vent backflow preventers.
  - 2. Reduced-pressure-principle backflow preventers.
  - 3. Double-check backflow-prevention assemblies.
  - 4. Water pressure-reducing valves.
  - 5. Primary, thermostatic, water mixing valves.
  - 6. Supply-type, trap-seal primer valves.
- I. Install trap seal guards in accordance with manufacturer's instructions.

### 3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install suction diffuser and shutoff valve on suction side of pumps.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
  - 1. Test each reduced-pressure-principle backflow preventer and double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

### 3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.
- D. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 221119

## SECTION 221316 - SANITARY WASTE AND VENT PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
  - 1. Pipe, tube, and fittings.
  - 2. Special pipe fittings.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control inspection and test reports.

#### 1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Solid-Wall PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.



1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
  2. Solvent Cement and Adhesive Primer:
    - a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. CPVC Plastic Pipe: ASTM F 2618 / ASTM D 3311, ASTM E84 25/50, with wall thickness as indicated in "Piping Applications" Article.
1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings with drain, waste, and vent patterns.
  2. Special drainage systems for corrosive chemical, acid waste, or high temperature waste systems shall be manufactured from CPVC Type IV, minimum ASTM Cell Classification 23447.
  3. Non-pressure drainage service temperature to 220 deg F.
  4. System pipe and fittings shall be manufactured in accordance with ASTM F 2618 and certified by NSF International for use in corrosive waste drainage systems.
  5. Pipe and fittings tested dry shall be Listed by ICC-ES PMG to ASTM E84/UL723 having a flame spread of less than 25 and smoke developed index of less than 50 and Listed by Underwriters Laboratories
  6. Flame spread of less than 25 and smoke developed index of less than 50 as designated on the pipe marking or fitting package labeling. All pipe markings shall be accompanied by a yellow stripe for identification as CPVC chemical waste drainage system.
  7. All fittings shall be CPVC drainage patterns meeting the applicable requirements of ASTM D 3311 or the manufacturer's specifications.
  8. Joining method for pipe and fittings shall be solvent cement welding. Solvent cement shall be a "one-step" primerless type CPVC cement specially formulated for resistance to corrosive chemicals and manufactured in accordance with ASTM F 2618 and F 493.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- C. Aboveground, soil, waste, and vent piping NPS 6 and smaller shall be any of the following:
  1. Solid-wall PVC pipe, DWV Socket-type pipe fittings with drain, waste, and vent patterns, and solvent-cemented joints with UL listed pipe insulation.

- D. Aboveground, acid waste, and vent piping NPS 6 and smaller located IN or communicating with the return air plenum shall be any of the following:
  - 1. CPVC Plastic Pipe: ASTM F 2618 / ASTM D 3311, ASTM E84 25/50 with CPVC Plastic Pipe Fittings: DWV Socket-type pipe fittings with drain, waste, and vent patterns with UL listed pipe insulation.
- E. Aboveground, condensate drainage piping NPS 1 and smaller located IN or communicating with the return air plenum shall be any of the following:
  - 1. Solid-wall PVC pipe, DWV Socket-type pipe fittings with drain, waste, and vent patterns, and solvent-cemented joints with UL listed pipe insulation.
- F. Underground, soil, waste, and vent piping NPS 8 and smaller shall be any of the following:
  - 1. Solid-wall PVC pipe, DWV Socket-type pipe fittings with drain, waste, and vent patterns, and solvent-cemented joints.
- G. Underground, grease soil, waste, and vent piping NPS 6 and smaller shall be any of the following:
  - 1. CPVC Plastic Pipe: ASTM F 2618 / ASTM D 3311, ASTM E84 25/50 with CPVC Plastic Pipe Fittings: DWV Socket-type pipe fittings with drain, waste, and vent patterns.
- H. Underground, acid waste, and vent piping NPS 6 shall be any of the following:
  - 1. CPVC Plastic Pipe: ASTM F 2618 / ASTM D 3311, ASTM E84 25/50 with CPVC Plastic Pipe Fittings: DWV Socket-type pipe fittings with drain, waste, and vent patterns.

### 3.2 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of

different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- E. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
  - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- G. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- H. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- I. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

### 3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
- C. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
  - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
  - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  2. NPS 3: 60 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
  4. NPS 6: 60 inches with 3/4-inch rod.
  5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
  2. NPS 3: 48 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  4. NPS 6: 48 inches with 3/4-inch rod.
- H. Install supports for vertical PVC piping every 48 inches.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.5 CONNECTIONS

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

### 3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction. Test underground sanitary drainage and vent piping before and after piping is concealed and backfill is compacted and before concrete floors are poured.
  1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  2. Prepare reports for tests and required corrective action. Retain a copy of test reports at the jobsite and include test reports in the project's closeout documentation.

### 3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.8 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint. Painting shall be provided and installed by the plumbing contractor.

END OF SECTION 221316

## SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains and sinks.
3. Sump pumps.
4. Plaster trap.
5. Acid neutralization trap.
6. Trench drain.
7. Miscellaneous sanitary drainage piping specialties.
8. Flashing materials.

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

#### 1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### PART 2 - PRODUCTS

#### 2.1 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:

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. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - b. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping

4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. All in-line cleanouts located within the return air plenum shall be cast iron body with bronze plugs. Provide and install transition fittings to CPVC/PCV pipe systems.

B. Wall Cleanouts:

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. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - b. Zurn Plumbing Products Group; Specification Drainage Operation.
  - c. Mifab Inc.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

## 2.2 FLOOR DRAINS AND SINKS

A. Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - b. Zurn Plumbing Products Group; Light Commercial Operation.
  - c. Zurn Plumbing Products Group; Specification Drainage Operation.
  - d. Mifab, Inc.
2. Refer to the Plumbing Fixture Schedule for product basis.

## 2.3 SUMP PUMPS

A. Sump Pumps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



- a. Franklin Electric, Little Giant.
- b. Liberty Pumps.
- c. Weil.

B. Refer to the Plumbing Fixture Schedule for product basis and capacities.

## 2.4 PASTER TRAPS

### A. Plaster Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Canplas Endura – In-Floor Trap
  - b. Praction – Gelco Under Sink Trap
2. Refer to the Plumbing Fixture Schedule for product basis.

## 2.5 ACID NEUTRALIZATION TRAPS

### A. Acid Neutralization Traps (In-Floor Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Striem
2. Refer to the Plumbing Fixture Schedule for product basis.

### B. Acid Neutralization Traps (Appliance Point-of-Use):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Axiom.
  - b. JJM Alkaline Technologies.
2. Refer to the Plumbing Fixture Schedule for product basis.

## 2.6 TRENCH DRAINS

### A. Trench Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.

- b. Sioux Chief Manufacturing Company, Inc.
- c. WATTS.
- d. Zurn Industries, LLC.

2. Refer to the Plumbing Fixture Schedule for product basis.

## 2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

### A. Trap Seals:

- 1. Rectorseal Trap Guard
- 2. Floor drains and floor sinks shall be provided with a Trap Guard where indicated on the drawings.

### B. Air-Gap Fittings:

- 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
- 2. Body: Bronze or cast iron.
- 3. Inlet: Opening in top of body.
- 4. Outlet: Larger than inlet.
- 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

### C. Sleeve Flashing Device:

- 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
- 2. Size: As required for close fit to riser or stack piping.

## 2.8 FLASHING MATERIALS

### A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

- 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
- 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
- 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

### B. Fasteners: Metal compatible with material and substrate being fastened.

### C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- G. Assemble open drain fittings and install with top of hub 1 inch above floor.
- H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- I. Install Trap Guard on floor drains and floor sinks as indicated on the drawings.
- J. Install trench drains at low points of surface areas to be drained.
  - 1. Set grates of drains flush with the finished surface.
  - 2. Refer to the drawings for additional requirements.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- N. 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.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### 3.3 FLASHING INSTALLATION

- A. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.
- B. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

## SECTION 221323 - SANITARY WASTE INTERCEPTORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Grease interceptors.

#### 1.2 SUBMITTALS

A. Shop Drawings: For each type and size of precast concrete interceptor indicated. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

### PART 2 - PRODUCTS

#### 2.1 GREASE INTERCEPTORS

A. Plastic Grease Interceptors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Schier Products Company.
2. Standard: PDI G101 and ASME A112.14.3, for intercepting and retaining FOG from food-preparation or -processing wastewater.
3. PDI Seal: Required.
4. Body Material: Polyethylene.
5. Body Dimensions: See Plans.
6. Body Extension: See Plans.
7. Capacities and Characteristics:
  - a. Length by Width by Depth: See Plans.
  - b. Number of Compartments: See Plans.
  - c. Flow Rate: See Plans.
  - d. Retention Capacity: See Plans
  - e. Inlet and Outlet Pipe Size: See Plans.
  - 1)Centerline of Inlet to Floor: N/A.
  - 2)Centerline of Outlet to Floor: N/A.

- f. End Connections: Hub.
  - g. Cleanout: field installed on outlet.
  - h. Trapped Outlet Required: No
  - i. Vent Pipe Size: 2" NPS.
  - j. Mounting: See Plans
  - k. Flow-Control Fitting: Not required.
  - l. Operation: Manual cleaning.
- B. Access: Minimum (1) access openings with traffic-rated covers where installed in vehicular areas. Riser extensions as required to finished grade.
- 1. Covers:
    - a. H-20 traffic-rated cast iron covers where applicable.
    - b. Gas-tight and watertight where required.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling per the project requirements.

### 3.2 INSTALLATION

- A. Equipment Mounting:
  - 1. Install above ground grease interceptors and solids interceptors directly on the floor as indicated on the plans.
- B. Install interceptor inlets and outlets at elevations indicated.
- C. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Make piping connections between interceptors and piping systems.
- E. Set interceptors level and plumb.
- F. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
  - 1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.
  - 2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
  - 3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.

4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

### 3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

### 3.4 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
  1. Use warning tapes or detectable warning tape over ferrous piping.
  2. Use detectable warning tape over nonferrous piping and over edges of underground structures.
- B. Equipment Nameplates and Signs: Sewer access covers with integral sign on each of the following:
  1. Grease interceptors.

### 3.5 PROTECTION

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 221323



## SECTION 221413 - FACILITY STORM DRAINAGE PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following storm drainage piping inside the building.

1. Pipe, tube, and fittings.
2. Special pipe fittings.

#### 1.2 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Storm Drainage Piping: 30-foot head of water.

#### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control inspection and test reports.

#### 1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

A. Solid-Wall PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns.

2. Solvent Cement and Adhesive Primer:

- a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 8 and smaller shall be any of the following:
  1. Solid-wall PVC pipe, PVC-DWV Socket-type pipe fittings with drain, waste, and vent patterns, and solvent-cemented joints with UL listed pipe insulation.
- C. Underground storm drainage piping NPS 8 and smaller shall be any of the following:
  1. Solid-wall PVC pipe, PVC-DWV Socket-type pipe fittings with drain, waste, and vent patterns, and solvent-cemented joints.

### 3.2 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."
- D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- E. Install cast-iron piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

- F. Install wall-penetration-fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- G. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
  - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- K. Install PVC storm drainage piping according to ASTM D 2665.
- L. Install underground PVC storm drainage piping according to ASTM D 2321.
- M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

### 3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
  - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
  3. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
  2. NPS 3: 48 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  4. NPS 6: 48 inches with 3/4-inch rod.
- F. Install supports for vertical PVC piping every 48 inches.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.5 CONNECTIONS

- A. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect storm drainage piping to roof drains and storm drainage specialties.

### 3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction.

### 3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413

## SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following storm drainage piping specialties:

1. Cleanouts.
2. Roof Drains.
3. Overflow Roof Drains.
4. Downspout Nozzles.

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

#### 1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### PART 2 - PRODUCTS

#### 2.1 CLEANOUTS

A. Cast-Iron Cleanouts:

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. Josam Company; Josam Div.
  - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - c. Watts Drainage Products Inc.
  - d. Zurn Plumbing Products Group; Light Commercial Operation.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. MIFAB, Inc.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping

4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Wall Cleanouts:

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. Josam Company; Josam Div.
  - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - c. Watts Drainage Products Inc.
  - d. Zurn Plumbing Products Group; Light Commercial Operation.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. MIFAB, Inc.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

## 2.2 ROOF DRAINS

A. Cast-Iron Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company; Josam Div.
  - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - c. Watts Drainage Products Inc.
  - d. Zurn Plumbing Products Group; Light Commercial Operation.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. MIFAB, Inc.
2. Refer to the Plumbing Fixture Schedule for product basis.

## 2.3 OVERFLOW ROOF DRAINS

### A. Cast-Iron Overflow Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company; Josam Div.
  - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - c. Watts Drainage Products Inc.
  - d. Zurn Plumbing Products Group; Light Commercial Operation.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. MIFAB, Inc.
2. Refer to the Plumbing Fixture Schedule for product basis.

## 2.4 DOWNSPOUTS NOZZLES

### A. Downspout Nozzles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company; Josam Div.
  - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - c. Watts Drainage Products Inc.
  - d. Zurn Plumbing Products Group; Light Commercial Operation.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Refer to the Plumbing Fixture Schedule for product basis.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  2. Locate at each change in direction of piping greater than 45 degrees.
  3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.



- 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
  - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
  - 2. Position roof drains for easy access and maintenance.
- F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- G. 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.
- H. Install downspout nozzles according to the manufacturer's written installation instructions. Seal penetrations in exterior walls water tight.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

### 3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

## SECTION 223100 - DOMESTIC WATER SOFTENERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes commercial water softeners.
  - 1. Commercial water softeners.
  - 2. Chemicals.
  - 3. Water testing kits.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of water softener and water testing kit indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and connections to piping systems.
  - 1. Include wiring diagrams.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

#### 1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.
  - 1. Water Softener, Warranty Period: Five years from date of Substantial Completion.

## 1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Salt for Brine Tanks: Furnish same form as and at least two times original load. Deliver on pallets in or 50-lb packages.
  - 2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 COMMERCIAL WATER SOFTENERS

- A. Description: Factory-assembled, pressure-type water softener.
  - 1. Manufacturers:
    - a. Culligan International Company.
  - 2. Comply with NSF 61, "Drinking Water System Components--Health Effects."
  - 3. Configuration: Refer to Plumbing Schedule and Details for configuration, capacity, and performance.
  - 4. Mineral Tanks: Steel tank, epoxy lined pressure-vessel quality.
    - a. Construction: Non-ASME code.
    - b. Pressure Rating: 125 psig minimum.
    - c. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
    - d. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
    - e. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.
    - f. Manhole: 11 by 15 inches in top head of tanks larger than 30 inches in diameter.
    - g. Support Legs or Skirt: Constructed of structural steel, welded to tank.
    - h. Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.

- i. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
  - j. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
  - k. Liner: Epoxy suitable for potable water.
5. Controls: Fully automatic; factory mounted on unit and factory wired.
- a. Adjustable duration of various regeneration steps.
  - b. Push-button start and complete manual operation.
  - c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
  - d. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
  - e. Pointer on pilot-control valve shall indicate cycle of operation.
  - f. Means of manual operation of pilot-control valve if power fails.
  - g. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
    - 1) Slow opening and closing, nonslam operation.
    - 2) Diaphragm guiding on full perimeter from fully open to fully closed.
    - 3) Isolated dissimilar metals within valve.
    - 4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
    - 5) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
    - 6) Sampling cocks for soft water.
    - 7) Special tools are not required for service.
  - h. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.
    - 1) Demand-Initiated Control: Equip single mineral-tank units with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons. Design so head automatically resets to preset total in gallons for next service run.
    - 2) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.
6. Brine Tank: Combination measuring and wet-salt storing system.
- a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.

- b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
- c. Size: Large enough for at least four regenerations at full salting.

7. Factory-Installed Accessories:

- a. Piping, valves, tubing, and drains.
- b. Sampling cocks.
- c. Main-operating-valve position indicators.
- d. Controllers.

## 2.3 CHEMICALS

- A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
  - 1. Exchange Capacity: 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
- B. Salt for Brine Tanks: High-purity sodium chloride; free of dirt and foreign material. Rock and granulated forms are not acceptable.
  - 1. Form: Processed, food-grade salt pellets.

## 2.4 WATER TESTING SETS

- A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

# PART 3 - EXECUTION

## 3.1 WATER SOFTENER INSTALLATION

- A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
- C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- D. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
  - 1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
  - 2. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
- E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
  - 1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
- F. Install valved bypass water piping around water softeners.
  - 1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
  - 2. Water piping is specified in Division 22 Section "Domestic Water Piping."
- G. Install drains as indirect wastes to spill into open drains or over floor drains.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- J. Provide and install plastic equipment labels for the water softeners and brine tank that match plan code designations. Attach to each water softener and associated brine tank. Refer to Division 22 section "Identification for Plumbing Piping and Equipment" for equipment label requirements.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, startup, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

- B. Add water to brine tanks and fill with salt.
  - 1. Commercial Water Softeners: Food-grade salt pellets.
- C. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
  - 1. ASTM D 859, "Test Method for Silica in Water."
  - 2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
  - 3. ASTM D 1068, "Test Methods for Iron in Water."
  - 4. ASTM D 1126, "Test Method for Hardness in Water."
  - 5. ASTM D 1129, "Terminology Relating to Water."
  - 6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."
- E. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water softeners. Perform Owner training with the water softeners outlining how to operate the system.
  - 1. Standard water softener operation where the softener act together to limit the pressure drop seen in the system as the demand on the domestic water system increases. The second softener will engage on as the demand increases to limit the pressure drop seen in the system to 15 psig.

END OF SECTION 223100

## SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following fuel-fired water heaters:
  - 1. Commercial, high-efficiency, storage, gas water heaters.
  - 2. Water heater accessories.
  - 3. Domestic water expansion tanks.

#### 1.2 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty.
- E. Factory startup reports.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

#### 1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.



1. Failures include, but are not limited to, the following:
  - a. Structural failures including storage tank and supports.
  - b. Faulty operation of controls.
  - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period(s): From date of Substantial Completion:
  - a. Storage Tank: Three years.
  - b. Controls and other components: Three years.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 COMMERCIAL, GAS WATER HEATERS

- A. Commercial, Power-Burner, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
  1. Manufacturers:
    - a. Reheem.
    - b. Bradford White.
  2. Storage-Tank Construction: Non-ASME-code steel with 150-psig working-pressure rating.
    - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
    - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
  3. Factory-Installed, Storage-Tank Appurtenances:
    - a. Anode Rod: Replaceable magnesium.
    - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.

- c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
  - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
  - e. Jacket: Steel with enameled finish.
  - f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
4. Burner: Comply with UL 795 for power-burner water heaters and for natural-gas fuel.
- a. Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
5. Temperature Control: Adjustable thermostat.
6. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
7. Special Requirements: NSF 5 construction.
8. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
- B. Capacity and Characteristics: Refer to the Plumbing Drawings for Capacity and Characteristics.

## 2.3 WATER HEATER ACCESSORIES

- A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
- B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
- C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

## 2.4 DOMESTIC WATER EXPANSION TANKS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amtrol.
  - 2. Grundfos.
  - 3. Taco.
- B. Bladder type for potable water applications and permanent separation of air and water. Water expands into bladder, air precharge on the shell side.
- C. Shell: Fabricated steel constructed to ASME Section VIII, Div. 1.

- D. Bladder: Heavy duty butyl, removable for inspection.
- E. Working Pressure: 150 psi.
- F. Operating Temperature: 240 F maximum.
- G. All wetted components of FDA approved materials.
- H. Provide with charging valve, lifting rings, stainless steel system connection and drain.
  - 1. Refer to Drawings for capacities.

## PART 3 - EXECUTION

### 3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install gas water heaters according to NFPA 54.
  - 1. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
  - 2. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
  - 3. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial, water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- E. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- F. Fill water heaters with water.
- G. Install domestic water expansion tanks where shown on the Drawings. Set expansion tank precharge pressure to the incoming water pressure.

- H. Record the precharge pressure on the side of the domestic hot water expansion tanks with a plastic equipment label for future reference. Refer to Division 22 section "Identification for Plumbing Piping and Equipment" for equipment label requirements.
- I. Install plastic equipment labels on all new domestic hot water heaters and potable water expansion tanks. Equipment labels shall match plan code designations. Refer to Division 22 section "Identification for Plumbing Piping and Equipment" for equipment label requirements.

### 3.2 CONNECTIONS

- A. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to inspect installation, including connections.
- B. Perform the following field tests and inspections:
  - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters.

END OF SECTION 223400

## SECTION 224000 - PLUMBING FIXTURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Faucets for lavatories, showers and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
6. Water closets.
7. Urinals.
8. Lavatories.
9. Stainless steel sinks.
10. Service and laundry sinks.
11. Electric Water Coolers/Bottle Fillers.
12. Emergency fixtures.
13. Showers.
14. Therapy tubs.

#### 1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. FRP: Fiberglass-reinforced plastic.
- D. PMMA: Polymethyl methacrylate (acrylic) plastic.
- E. PVC: Polyvinyl chloride plastic.
- F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category from a single manufacture that meets the specified criteria for each category. Note: This does not preclude use of components from different manufactures in an assembly, such as lavatory and faucet.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
  - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
  - 2. Plastic Laundry Trays: ANSI Z124.6.
  - 3. Plastic Shower Enclosures: ANSI Z124.2.
  - 4. Plastic Sinks: ANSI Z124.6.
  - 5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
  - 6. Slip-Resistant Bathing Surfaces: ASTM F 462.
  - 7. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
  - 8. Stainless-Steel Residential Sinks: ASME A112.19.3.
  - 9. Vitreous-China Fixtures: ASME A112.19.2M.
  - 10. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
  - 11. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
  2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
  3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
  4. Faucets: ASME A112.18.1.
  5. Hose-Connection Vacuum Breakers: ASSE 1011.
  6. Hose-Coupling Threads: ASME B1.20.7.
  7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
  8. NSF Potable-Water Materials: NSF 61.
  9. Pipe Threads: ASME B1.20.1.
  10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
  11. Supply Fittings: ASME A112.18.1.
  12. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for shower faucets:
1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
  2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
  3. Faucets: ASME A112.18.1.
  4. Hand-Held Showers: ASSE 1014.
  5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
  6. Hose-Coupling Threads: ASME B1.20.7.
  7. Manual-Control Antiscald Faucets: ASTM F 444.
  8. Pipe Threads: ASME B1.20.1.
  9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
  10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
  11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
  2. Brass and Copper Supplies: ASME A112.18.1.
  3. Dishwasher Air-Gap Fittings: ASSE 1021.
  4. Manual-Operation Flushometers: ASSE 1037.
  5. Plastic Tubular Fittings: ASTM F 409.
  6. Brass Waste Fittings: ASME A112.18.2.
  7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
  2. Dishwasher Air-Gap Fittings: ASSE 1021.
  3. Flexible Water Connectors: ASME A112.18.6.
  4. Grab Bars: ASTM F 446.
  5. Hose-Coupling Threads: ASME B1.20.7.

6. Hot-Water Dispensers: ASSE 1023 and UL 499.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply and Drain Protective Shielding Guards: ICC A117.1.

## PART 2 - PRODUCTS

- 2.1 Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category from a single manufacture that meets the specified criteria for each category. Note: This does not preclude use of components from different manufactures in an assembly, such as lavatory and faucet.

### 2.2 LAVATORY FAUCETS

#### A. Lavatory Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Chicago Faucet
  - b. T&S Brass
  - c. Zurn
2. Description: As outlined on the plumbing drawings.

### 2.3 SHOWER FAUCETS

#### A. Shower Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Acorn
  - b. Delta
  - c. Zurn
  - d. Bradley.
2. Description: As outlined on the plumbing drawings.

### 2.4 SINK FAUCETS

#### A. Sink Faucets:



1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Chicago Faucet
  - b. T&S Brass
  - c. Zurn
2. Description: As outlined on the plumbing drawings.

## 2.5 MOP SINK FAUCETS

### A. Sink Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Chicago Faucet
  - b. T&S Brass
  - c. Zurn
2. Description: As outlined on the plumbing drawings.

## 2.6 FLUSHOMETERS

### A. Flushometers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Sloan Valve Company
  - b. Zurn
2. Description: As outlined on the plumbing drawings.

## 2.7 TOILET SEATS

### A. Toilet Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. American Standard.
  - b. Bemis Manufacturing Company.
2. Description: As outlined on the plumbing drawings.

## 2.8 PROTECTIVE SHIELDING GUARDS OR SKIRT KIT

### A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Engineered Brass Co.
  - b. McGuire Manufacturing Co., Inc.
  - c. TRUEBRO, Inc.
  - d. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
3. A skirt may be used only if it matches the cabinet material used in each area. Skirts shall be provided by the casework supplier and are shown on the architectural drawings and specifications.
  - a. Model # TRUEBRO Undersink Pipe Guard #82525 Item #15W937

## 2.9 FIXTURE SUPPORTS

### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
5. Zurn Plumbing Products Group; Specification Drainage Operation.

### B. Water-Closet Supports:

1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hub-less waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. See the plumbing DWV remodel drawings for configurations required.

### C. Urinal Supports:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

## 2.10 WATER CLOSETS

A. Water Closets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. American Standard Companies, Inc.
  - b. Kohler
  - c. Sloan
  - d. Zurn
2. Description: As outlined on the plumbing drawings.

## 2.11 URINALS

A. Urinals:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. American Standard Companies, Inc.
  - b. Kohler
  - c. Sloan
  - d. Zurn
2. Description: As outlined on the plumbing drawings.

## 2.12 LAVATORIES

A. Lavatories:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. American Standard Companies, Inc.
  - b. Kohler
  - c. Sloan
  - d. Zurn
2. Description: As outlined on the plumbing drawings.

## 2.13 STAINLESS STEEL SINKS

### A. Stainless Steel Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Elkay Manufacturing Co.
  - b. Just Manufacturing
2. Description: As outlined on the plumbing drawings.

## 2.14 SERVICE SINKS

### A. Service Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Crane Plumbing, L.L.C.
  - b. Fiat Products.
2. Description: As outlined on the plumbing drawings.

### B. Laundry Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Crane Plumbing, L.L.C.
  - b. Fiat Products.
2. Description: As outlined on the plumbing drawings.

## 2.15 ELECTRIC WATER COOLER/BOTTLE FILL STATIONS

### A. Electric Water Cooler/Bottle Fill Stations:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Elkay Manufacturing Co.
2. Description: As outlined on the plumbing drawings.

## 2.16 EMERGENCY FIXTURES

### A. Combination Eye Wash / Shower OR Stand Alone Eye/Face Wash:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Guardian.
  - b. HAWS.
2. Description: As outlined on the plumbing drawings.
3. Provide ASSE 1071 thermostatic mixing valve to serve each emergency fixture. Refer to the plumbing drawings for additional requirements.

## 2.17 SHOWER BASES

### A. Shower Bases:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Acorn Engineering
2. Description: Precast-terrazzo base for built-up-type shower fixture.
3. Standard: CSA B45.8/IAPMO Z403.
4. 2010 ADA Standards for Accessible Design.
5. Threshold Type: See plans.
6. Shape: Rectangular, see plans for size.
7. Nominal Size: see plans.
8. Color: By Architect from manufacturer's standard color selection.
9. Outlet: See drawings.
10. Tiling Flange: Integral, stainless steel.
  - a. Refer to the plumbing drawings for additional requirements.

## 2.18 THERAPY TUBS

### A. Electric Water Cooler/Bottle Fill Stations:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Whitehall Mfg.
2. Description: As outlined on the plumbing drawings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
  - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
  - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
  - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install fixtures level and plumb according to roughing-in drawings.
- G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

- I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- J. Install flushometer 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.
- K. Install toilet seats on water closets.
- L. 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.
- M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- N. 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.
- O. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- P. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
  - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- Q. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- R. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.
- S. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.
- T. 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. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

### 3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

### 3.5 PROTECTION AND ADJUSTING

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.
- C. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- D. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- E. Replace washers and seals of leaking and dripping faucets and stops.
- F. Install fresh batteries in sensor-operated mechanisms.
- G. Adjust thermostatic mixing valve on all standard and emergency fixtures.



### 3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
  - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
  - 2. Remove sediment and debris from drains.

END OF SECTION 224000

## SECTION 230000 - MECHANICAL GENERAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 MECHANICAL REQUIREMENTS

- A. The mechanical requirements are supplemental to the General Requirements of these Specifications. The Mechanical Sections shall apply to all phases of the work specified, shown on the Drawings, or required to provide for the complete installation of Mechanical Systems for this project.
- B. The work shall include all items, articles, materials, operations and methods listed, mentioned, or scheduled in these specifications and the accompanying drawings. All material, equipment, and labor shall be furnished together with all incidental items required by good practice to provide the complete systems described.
- C. Examine and refer to all Architectural, Civil, Structural, Electrical, Plumbing, Landscape, Fire Protection, Food Service, Communication and Mechanical drawings and specifications for construction conditions which may affect the mechanical work. Inspect the building site for verification of present conditions. Make proper provisions for these conditions in performance of the work and cost thereof.
- D. See general requirements for listed Alternate Bids. Note alternates listed and include any changes in work and price required to meet the requirements of the respective alternate.

#### 1.2 CODES AND STANDARDS

- A. Work shall meet the requirements of the plans and specifications and shall not be less than the minimum requirements of applicable sections of the latest Codes and Standards of the following Organizations:
  - 1. American Gas Association (AGA)
  - 2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - 3. American Society of Mechanical Engineers (ASME)
  - 4. American Water Works Association (AWWA)
  - 5. National Electrical Code (NEC)
  - 6. National Electrical Manufacturers Association (NEMA)
  - 7. National Fire Protection Association (NFPA)
  - 8. International Plumbing Code (IPC)
  - 9. Occupational Safety & Health Act (OSHA)
  - 10. Plastic Pipe Institute (PPI)
  - 11. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
  - 12. International Mechanical Code (IMC)
  - 13. International Building Code (IBC)
  - 14. International Fuel Gas Code (IFGC)

- 15. Requirements of the Serving Utility Company
- 16. Local and State Codes and Ordinances
- 17. SMACNA Seismic Manual

### 1.3 FEES AND PERMITS

- A. The Mechanical Contractor shall pay all fees and arrange for all permits required for work done under his contract and under his supervision by subcontract.
- B. All usage contracts between the Owner and the serving utilities company, such as membership and usage charges or fees, etc., for the purpose of obtaining the services for the utility company shall be applied for and paid for by the Owner.

### 1.4 MATERIALS AND EQUIPMENT

- A. Manufacturers trade names and catalog numbers listed in each specification section and on the drawing schedules are intended to indicate the quality of equipment or materials desired. Manufacturers not listed must receive prior approval prior to bidding. Written prior approval must be obtained from the Architect/Engineer. Prior Approval Requests shall be submitted no later than ten (10) days prior to the bid date to allow time for examination. The items approved will be listed in an addendum and only this list of equipment will be accepted in lieu of specified products.
  - 1. All Prior Approval Requests shall indicate the specific item or items to be furnished in lieu of those specified, together with complete technical and comparative data on specified items and proposed items. Each specification section lists the project's pre-approved manufacturers.
- B. Mechanical equipment may be installed with manufacturer's standard finish and color except where specific color, finish or choice is indicated. If the manufacturer has no standard finish, equipment shall have a prime coat and two finish coats of gray enamel.
- C. This Contractor shall be responsible for materials and equipment installed under this contract. Contractor shall also be responsible for the protection of materials and equipment of others from damage as a result of his work.
- D. Manufactured material and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by manufacturer unless herein specified to the contrary.
- E. This Contractor shall make the required arrangement with General Contractor for the introduction into the building of equipment too large to pass through finished openings.
- F. Store materials and equipment indoors at the job site or, if this is not possible, store on raised platforms and protect from the weather by means of waterproof covers. Coverings shall permit circulation of air around the materials to prevent condensation of moisture. Screen or cap openings in equipment to prevent the entry of vermin.

## 1.5 INTENT OF DRAWINGS

- A. The drawings are partly diagrammatic and do not necessarily show exact location of piping and ductwork unless specifically dimensioned. Riser and other diagrams are schematic and do not necessarily show the physical arrangement of the equipment. They shall not be used for obtaining lineal runs of piping or ductwork, nor shall they be used for shop drawings for piping and ductwork fabrication or ordering.
- B. The drawing plans, schematics, and diagrams indicate the general location and arrangements of piping and ducting systems. Install piping and ducting in the general areas shown on the plans. If significant routing deviations are necessary to improve the system routings or avoid unforeseen conditions contact the Engineer for review.
- C. Discrepancies shown on different plans, or between plans and actual field conditions shall be brought to the attention of the Engineer for resolution.

## 1.6 RESPONSIBILITY

- A. The Mechanical Contractor shall be responsible for the installation of a satisfactory and complete system in accordance with the intent of the drawing and specifications. Provide, at no extra cost, all incidental items required for completion of the work even though they are not specifically mentioned or indicated on the drawings or in the specifications.
- B. The drawings do not attempt to show complete details of the building construction which affect the mechanical installation; and reference is therefore required to the existing facility, the existing facilities drawings, and to the Architectural, Civil, Structural, Landscape and Electrical drawings and specifications and to shop drawings of all trades for additional details which affect the installation of the work covered under this Division of the Contract.
- C. Location of mechanical system components shall be checked for conflicts with openings, structural members and components of other systems having fixed locations. In the event of any conflicts, the Architect/Engineer shall be consulted and his decision shall govern. Necessary changes shall be made at the Contractor's expense.
- D. Determine, and be responsible for, the proper location and character of inserts for hangers, chases, sleeves, and other openings in the construction required for the work, and obtain this information well in advance of the construction progress so work will not be delayed.
- E. Final location of inserts, hangers, etc., required for each installation, must be coordinated with facilities required for other installations to prevent interference.
- F. Take extreme caution not to install work that connects to equipment until such time as complete Shop Drawings of such equipment have been approved by the Architect/Engineer. Any work installed by the Contractor, prior to approval of Shop Drawings, will be at the Contractor's risk.

- G. At all times during the performance of this Contract, properly protect work from damage and protect the Owner's property from injury or loss. Make good any damage, injury or loss, except such as may be directly due to errors in the Bidding Documents or caused by Agents or Employees of the Owner. Adequately protect adjacent property as provided by law and the Bidding Documents. Provide and maintain passageways, guard fences, lights and other facilities for protection required by Public Authority or Local conditions.
- H. The Contractor shall be responsible for damages due to the work of their Contractors, to the building or its contents, people, etc.

## 1.7 REVIEW

- A. All work and material is subject to review at any time by the Architect/Engineer or his representative. If the Architect/Engineer or his representative finds material that does not conform with these specifications or that is not properly installed or finished, correct the deficiencies in a manner satisfactory to the Architect/Engineer at the Contractor's expense.

## 1.8 WORKMANSHIP

### A. GENERAL

- 1. Work under this contract shall be performed by workmen skilled in the particular trade, including work necessary to properly complete the installation in a workmanlike manner to present a neat and finished appearance.

### B. CUTTING, PATCHING, AND FRAMING

- 1. Obtain Architect's/Engineer's approval before performing any cutting on structural members or patching of building surfaces. Any damage to the building or equipment by this Contractor shall be the responsibility of this Contractor and shall be repaired by skilled craftsmen of the trades involved at the Contractor's expense.
- 2. Chases, openings, sleeves, hangers, anchors, recesses, equipment pads, framing for equipment, provided by others only if so noted on the drawings. Otherwise, they will be provided by this Contractor for his work. Whether chases, etc., are provided by this Contractor or others, this Contractor is responsible for correct size and locations.

## 1.9 COORDINATION

- A. This Contractor shall plan his work to proceed with a minimum interference with the Owner and other trades. Dimensions of equipment installed and/or provided by others shall be checked in order that correct clearances and connections may be made.

#### 1.10 CLEAN UP

- A. Keep the premises free from accumulation of waste material or rubbish caused by his work or employees.
- B. Upon completion of work, remove materials, scraps and debris relative to his work and leave the premises, including tunnels, crawl spaces, and pipe chases in clean and orderly condition. Remove all dirt and debris from the interior and exterior of all devices and equipment. After construction is completed, wash all mechanical equipment.

#### 1.11 DUST PROTECTION

- A. Contractor will provide suitable dust protection for all existing areas prior to beginning of cutting or demolition. Contractor will obtain approval of partition from Owner before proceeding with work involved in these rooms.

#### 1.12 TEMPORARY FACILITIES

##### A. OFFICES

- 1. Contractor shall provide a temporary office for himself and for the periodic use by the Architect\Engineer including:
  - a. Lights, heat, and telephone. (Pay telephone not permitted.)

##### B. REMOVAL

- 1. Contractor shall completely remove his temporary installations when no longer needed and the premises shall be completely clean, disinfected, patched, and refinished to match adjacent areas.

##### C. LADDERS AND SCAFFOLDS

- 1. The Contractor shall provide their own ladders, scaffolds, etc. of substantial construction for access to their work in various portions of the building as may be required. When no longer needed, they shall be removed by the Contractor.

##### D. PROTECTION DEVICES

- 1. The Contractor shall provide and maintain his own necessary barricades, fences, signal lights, etc., required by all governing authorities or shown on the drawings. When no longer needed, they shall be removed by the Contractor. The Contractor shall assume all responsibility for which the Owner may be held responsible because of lack of above items.

##### E. TEMPORARY WATER

- 1. The Contractor shall provide all water required by his trade for construction. Temporary drinking water shall be provided by Contractor from a proven safe

source dispensed by single service containers, until such time as the construction water outlet has been installed, disinfected, and approved for drinking purposes.

F. TEMPORARY FIRE PROTECTION

1. The Contractor shall provide all necessary first-aid hand fire extinguishers for Class A, B, C and special hazards as may exist in his own work area only in accordance with good and safe practice and as required by jurisdictional safety authority. The Contractor shall provide general area fire extinguishers only.

1.13 SHOP DRAWINGS (Product Submittals)

- A. Provide manufacturer's literature and/or certified prints as soon as possible but within thirty (30) days after awarding of Contract, for items of materials, equipment, or systems where called for in specifications. Shop drawings and literature complete showing item used, size, dimensions, capacity, rough-in, etc., as required for complete check and installation. Manufacturer's literature showing more than one item shall be clearly marked as to which item is being furnished or it will be rejected and returned without review.

B. Shop Drawing (Submittals) Format:

1. Submittals shall be compiled and submitted in PDF format. The PDF method shall be presented as one (1) entire package per submittal section with each item in the respective submittal division clearly tagged.
2. The entire Division 23 shall be submitted in one (1) entire package, except as noted below. Submittal Binder Cover shall include the following:

SUBMITTAL BINDER COVER

Date:

Name of Project:

Name of Contracting Company:

Name of Contracting Company Project Contact Person:

Contracting Company Phone Number:

Branch of Work:

3. Each item submitted must be typewritten and clearly marked as follows for purposes of identification and record. Submittals not typewritten or not marked as described below will be rejected and returned without review.

SUBMITTAL BINDER DIVISION SECTIONS (as listed below in the Schedule of Shop Drawings)

Specification Number and Title

Product Data Specification Number and Title (and Plan Code reference number where applicable)

C. Prior to Formal Submittal Binder Submission:

1. Transmit to the engineer a Submittal Binder Table of Contents for engineer review prior to formal submittal binder submission. The Table of Contents may be sent via facsimile or email methods. Once the Submittal Binder Table of Contents is

- approved by the engineer then the contractor shall submit the complete Submittal Binder.
2. Each submittal shall be thoroughly checked by the Contractor for compliance with the Contract Document requirements, accuracy of dimensions, relationship to the work of other trades, and conformance with sound, safe practices as to erection and installation. Each submittal shall then bear a stamp evidencing such checking and shall show corrections made, if any. Submittals requiring extensive corrections shall be revised before submission. Each submittal not stamped and signed by the Contractor evidencing such checking will be rejected and returned without review.
- D. All submittals will be examined when submitted in proper form for compliance. Such review shall not relieve the Contractor of responsibility for errors, for deviation from the contract Documents, nor for violation of sound safety practices.
- E. The Contractor shall keep in the field office one print of each submittal which has been reviewed and stamped by the Architect or Engineer.
- F. Submittals will be required for each product item as identified and listed in the Submittal paragraph for each respective specification section listed in the Schedule of Shop Drawings listed below in paragraph I.
- G. Submittals which are incomplete relative to quality requirements, capacity, engineering data, dimensional data or detailed list of specialty or control equipment will be rejected. Lists shall include descriptive coding as specified or shown on drawings.
- H. The Engineer will perform shop drawing review of each item; however, subsequent review of items previously rejected will be billed to the contractor at a rate of \$195 per hour.
- I. SCHEDULE OF SHOP DRAWINGS.
1. 23 05 00 Common Work Results For HVAC
  2. 23 05 19 Meters and Gages for HVAC Piping
  3. 23 05 23 General-Duty Valves for HVAC Piping
  4. 23 05 29 Hangers and Supports for HVAC Piping and Equipment
  5. 23 05 53 Identification for HVAC Piping and Equipment
  6. 23 05 93 Testing, Adjusting, and Balancing for HVAC
  7. 23 07 00 Insulation Piping and Ducting
  8. 23 09 00 Instrumentation and Control for HVAC
  9. 23 09 93 Sequence of Operations for HVAC Controls
  10. 23 11 23 Facility Natural-Gas Piping
  11. 23 21 13 Hydronic Piping
  12. 23 21 23 Hydronic Pumps
  13. 23 23 00 Refrigerant Piping
  14. 23 25 00 HVAC Water Treatment
  15. 23 31 13 Metal Ducts
  16. 23 33 00 Air Duct Accessories
  17. 23 34 23 HVAC Power Ventilators
  18. 23 36 00 Air Terminal Units
  19. 23 37 13 Diffusers, Registers, Grilles
  20. 23 37 23 HVAC Louvers



- 21. 23 38 13 Commercial Kitchen Hoods
- 22. 23 52 16 Condensing Boilers
- 23. 23 72 23.23 Packaged, Outdoor, Heat Wheel Energy Recovery Units
- 24. 23 74 16.11 Packaged Rooftop Air Conditioning Units
- 25. 23 74 23.13 Direct Fired Outdoor Makeup Air Units
- 26. 23 81 26 Split – System Air Conditioners
- 27. 23 82 39 Unit Heaters

- J. Should the contractor be required to re-submit, then the entire submittal package shall be re-submitted, unless prior permission is received from the engineer for some other method.

#### 1.14 OPERATION AND MAINTENANCE MANUALS

- A. At the time orders are placed for any item of equipment requiring service or operating maintenance, the Contractor shall request the manufacturer furnish three (3) hard copies and one (1) electronic PDF copy of OPERATION AND MAINTENANCE INSTRUCTIONS for each piece of equipment. These shall be included in the brochure of equipment.

#### 1.15 BROCHURE OF EQUIPMENT

- A. Upon completion of work, prepare three (3) hard copies and one (1) electronic PDF copy of "Brochure of Equipment" containing data pertinent to equipment and systems on job. Binders containing materials shall be one or more three ring binders of sufficient number to hold all literature. Contained in binders shall be: Installation, maintenance, and operating instructions for each piece of equipment; parts lists; wiring diagrams; one copy of each shop drawing and literature submittal; record drawings, etc. PDF copy shall contain the same material as the hard copies and shall be delivered with the hard copies via a flash drive. The PDF method shall be presented with each respective item clearly tagged as such.
- B. All literature shall be clean, unused and filed under divider headings corresponding to the specifications.
- C. These brochures shall be submitted to the Architect/Engineer and approved by him before authorization of final payment.
- D. Equipment startup reports for equipment installed shall be submitted to the Architect/Engineer and included in the brochures.
- E. Owner signed, Owner Training documents shall be included in the brochures.

#### 1.16 AS-BUILT DRAWINGS

- A. The Contractor shall furnish to the Architect/Engineer a marked print showing the location of all mechanical equipment, plumbing fixtures, piping, ductwork, diffusers,

grilles, etc. The location of any item which deviates from the bid documents shall be accurately drawn and dimensioned.

- B. The location of all maintenance related items such as duct access doors, fire dampers, isolation valves, filters, etc., shall be highlighted on as built drawing.
- C. One (1) complete full size paper copy and a scanned (in color) PDF electronic copy of the as-built drawings shall be provided.

#### 1.17 PLACING SYSTEMS IN OPERATION

- A. At the completion of the work and at such time as the Owner shall direct, prior to final acceptance, the Contractor performing this work shall put into satisfactory operation the various systems installed under the specifications. At no additional cost to the Owner, furnish the services of a person completely familiar with the installations performed under this specification, to instruct the Owner's operating personnel in the proper operation and servicing of the equipment and systems. These services shall be available for a period of no less than one (1) day and shall be scheduled no less than one (1) week prior to conducting.

#### 1.18 WARRANTY

- A. The Contractor shall guarantee that all materials and labor installed are new and of first quality and that any material or labor found defective shall be replaced without cost to the Owner within one (1) year after substantial completion of the Contract or one (1) full season of heating and cooling operation, whichever is the greater. The guarantee shall list the date of the beginning of the one (1) year period, which shall be the date that the Substantial Completion Certificate is issued.
- B. Any damage to the building, caused by defective work or material of the Contractor within the above-mentioned period, shall be satisfactorily repaired without cost to the Owner.
- C. The guarantee does not include maintenance of equipment. The Owner shall accept full responsibility for proper operation and maintenance of equipment immediately upon substantial completion and occupancy of the building.
- D. Final acceptance by the Owner will not occur until all operating instructions are mounted in Equipment Rooms and Operating Personnel thoroughly indoctrinated in the operation of all mechanical equipment by the Contractor.
- E. Any equipment, including heat exchangers, boilers, pumps, air handlers, motors, etc., used for temporary heat, shall be brought up to a new condition before final acceptance by the Owner and shall be guaranteed by the Contractor as new equipment.
- F. During the warranty period, if system or equipment issues arise, the Contractor shall submit a warranty report to the Architect/Engineer identifying the issue and what was done to correct the issue. The warranty report shall identify the date the issue was

discovered, when the issue was resolved, and the key personal involved in resolving the issue.

END OF SECTION 230000

## SECTION 230500 - COMMON WORK RESULTS FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. Equipment installation requirements common to equipment sections.
8. Concrete bases.
9. Supports and anchorages.

#### 1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### 1.3 QUALITY ASSURANCE

- A. Retain first two paragraphs below if support welding and pipe welding are retained in "Pipe Joint Construction" and "Erection of Metal Supports and Anchorages" articles. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

- C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT MANUFACTURERS

- A. Equipment in each of the following categories shall be of one manufacture or available through one manufacture, or vendor, for each category to facilitate ease of maintenance for the Owner.
  - 1. Thermometers.
  - 2. Pressure Gauges
  - 3. Gate, Plug, and Check Valves
  - 4. Butterfly Valves
  - 5. Ball Valves
  - 6. Balancing Valves
  - 7. Dielectric Unions
  - 8. Strainers
  - 9. Air Filters

### 2.2 PIPE, TUBE, AND FITTINGS

- A. Welded heating hot water piping will not be permitted on this project.
- B. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- C. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is 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 or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
  - 1. CPVC Piping: ASTM F 493.
  - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

## 2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

## 2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Sleeve in paragraph below is available with many end variations.
- D. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- E. Sleeve in paragraph below is without seepage holes.
- F. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.

## 2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. Do not delete or combine types of escutcheons in three paragraphs below until selections in Part 3 "Piping Systems - Common Requirements" Article are made.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- D. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated.
- E. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated.

## 2.8 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, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 CEILING ACCESS PANELS

- A. Provide ceiling access panels in hard lid ceilings as required to provide access to equipment, piping, piping accessories, ductwork, duct accessories etc. requiring access. Refer to Division 08 - ACCESS DOORS AND PANELS for ceiling access panel requirements. Coordinate access panel locations with the Architect prior to installation.

### 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 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 generally shown on the drawings. Significant deviations to layouts shall be reviewed and approved with the Engineer.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.



- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Edit first paragraph below to suit Project and add description of firestopping sealant.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 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. 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 complying with ASTM B 32.
- E. 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.
- F. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. 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.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

### 3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### 3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

- B. Field Welding: Comply with AWS D1.1.

### 3.7 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 230500

## SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### 1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### PART 2 - PRODUCTS

#### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

#### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 4,500 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

#### 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.

- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. 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.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Provide shaft grounding rings for motors operated with variable frequency drives.

## 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
  2. Split phase.
  3. Capacitor start, inductor run.
  4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

### PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

## SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 LIQUID-IN-GLASS THERMOMETERS

##### A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Miljoco Corporation.
  - b. Terice, H. O. Co.
  - c. Winters Instruments - U.S.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass or acrylic.
8. Stem: Aluminum and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 THERMOWELLS

### A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.3 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Miljoco Corporation.
  - d. Terice, H. O. Co.
  - e. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-inch minimum nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass or acrylic.
10. Ring: Stainless steel.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.



## 2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle or ball valve, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install connection fittings in accessible locations for attachment to portable indicators.
- I. Install thermometers in the following locations:
  - 1. Where shown on the Drawings.
- J. Install pressure gages in the following locations:
  - 1. Where shown on the Drawings.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

### 3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers where shown on the drawings shall be the following:
  - 1. Industrial-style, liquid-in-glass type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

### 3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range: 30 to 240 deg F.

### 3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages where shown on the drawings shall be the following:
  - 1. Liquid-filled, direct-mounted, metal case.

### 3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Unless otherwise noted on the drawings, scale range shall be the following:
  - 1. Scale Range: 0 to 100 psi.

END OF SECTION 230519

## SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron, single-flange butterfly valves.
3. Iron swing check valves.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.
- B. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
1. Hand lever: For quarter-turn valves NPS 6 and smaller except plug valves.
- D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Threaded: With threads according to ASME B1.20.1.

## 2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim & Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Nibco.
  - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Model: Nibco – T-585-80-LF, Watts - LFB6080 G2
  - b. Standard: MSS SP-110.
  - c. SWP Rating: 150 psig.
  - d. CWP Rating: 600 psig.
  - e. Body Design: Two piece.
  - f. Body Material: Bronze.
  - g. Ends: Threaded.
  - h. Seats: PTFE or TFE.
  - i. Stem: Bronze.
  - j. Ball: Chrome-plated brass.
  - k. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim & Copper Pressure-Seal-Joint Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Viega.
  - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - c. Nibco.
2. Description:
  - a. Model: Viega – Model 2971.1ZL, Watts – Series LFFBV-3-Press, Nibco PC-585-80-LF
  - b. Standard: MSS SP-110.
  - c. CWP Rating: 200 psig.

- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Copper Pressure-Seal-Joint
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

## 2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

### A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Pentair Valves & Controls
  - b. Nibco
2. Description:
  - a. Model: Pentair Valves & Controls Keystone Series 222, Nibco Model N-200235
  - b. Standard: MSS SP-67, Type I.
  - c. CWP Rating: 150 psig or greater.
  - d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - e. Body Material: Cast Iron ASTM A126 Class B.
  - f. Seat: EPDM.
  - g. Stem: One- or two-piece stainless steel.
  - h. Disc: Aluminum bronze.

## 2.4 IRON SWING CHECK VALVES

### A. Ductile Iron Check Valves:

1. Manufactures: Subject to compliance with requirements, provide products by one of the following:
  - a. Grinnell; a division of Tyco Fire & Building Products.
  - b. Anvil International, Inc.
  - c. Victaulic Company of America.
2. Body: Ductile iron conforming to ASTM A 536
3. Clapper: Stainless steel.
4. Clapper Facing: Grade E EPDM.
5. Seat: Nickel-plated or stainless steel.
6. Coating: Non-lead enamel paint.
7. Spring: Stainless steel.
8. Ends: Grooved ends

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and per the manufacturer's installation guidelines.

### 3.3 ADJUSTING

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

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 10: Flanged ends.

### 3.5 HEATING HOT WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  1. Ball Valves: Provide threaded ends or Copper Pressure-Seal-Joint ends.
- B. Pipe NPS 2-1/2 and Larger:
  1. Iron, Single-Flange Butterfly Valves
  2. Iron Swing Check Valves.

END OF SECTION 230523

## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Steel pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Thermal-hanger shield inserts.
  - 5. Fastener systems.
  - 6. Equipment supports.
  - 7. Roof supports.
- B. See Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

#### 1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Thermal hanger shield inserts.

#### 1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.



## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
  - 1. B-Line Systems, Inc.; a division of Cooper Industries.
  - 2. ERICO/Michigan Hanger Co.
  - 3. Grinnell Corp.
  - 4. National Pipe Hanger Corporation.
  - 5. PHD Manufacturing, Inc.
  - 6. Piping Technology & Products, Inc.
  - 7. Tolco Inc.
  - 8. Other manufactures meeting the specification requirements.
- C. Coatings: Hot dipped galvanized, electro-galvanized or zinc plated steel.

### 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.
- B. Coatings: Hot dipped galvanized, electro-galvanized or zinc plated steel.

### 2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
  - 1. B-Line Systems, Inc.; a division of Cooper Industries.
  - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
  - 3. Power-Strut Div.; Tyco International, Ltd.
  - 4. Tolco Inc.

5. Unistrut Corp.; Tyco International, Ltd.
  6. Other manufactures meeting the specification requirements.
- C. Coatings: Hot dipped galvanized, electro-galvanized or zinc plated steel.

## 2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
1. ERICO/Michigan Hanger Co.
  2. Pipe Shields, Inc.
  3. Rilco Manufacturing Company, Inc.
  4. Value Engineered Products, Inc.
  5. Other manufactures meeting the specification requirements.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
1. Insert thickness shall match insulation thickness.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
1. Insert thickness shall match insulation thickness.
- E. Insulation-Insert Material for all pool water heater and boiler combustion air systems insulated with flexible elastomeric pipe insulation: Water-Repellant treated, ASTM C177, Closed Cell, Armaflex Insulation Insert with self-adhesive Thermal Insert:
1. Armacell Model # Armafix Pipe Hanger Support
  2. Color: Black.
  3. Insert thickness shall match insulation thickness.
- F. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- G. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- H. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Empire Industries, Inc.
- c. Hilti, Inc.
- d. ITW Ramset/Red Head.
- e. MKT Fastening, LLC.
- f. Powers Fasteners.
- g. Other manufactures meeting the specification requirements.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.
- B. Coatings: Hot dipped galvanized, electro-galvanized or zinc plated steel.

2.8 ROOF SUPPORTS

- A. Refer to Detail 5/M5.3 for requirements.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Non-staining, non-corrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
  3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
  4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated and insulated stationary pipes, NPS 1/2 to NPS 1 1/2.
  5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
  7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.

- c. Heavy (MSS Type 33): 3000 lb.
- 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- H. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- I. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- J. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
  - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
  - 1. Clamped piping:
    - a. Piping 1-1/2" and smaller: use protection shields. Shields shall span an arc of 180 degrees.
    - b. Piping 2" and larger: use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
  - 2. Hanger Supported piping:
    - a. Piping 1-1/2" and smaller: use protection shields. Shields shall span an arc of 180 degrees.
    - b. Piping 2" and larger: use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping
  - 3. Protection Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - 4. Insulation shall be continuous through the clamped and hanger supported piping.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

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

### 3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

#### 1.2 SUBMITTAL

##### A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

##### A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

##### B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules).

#### 2.2 PIPE LABELS

##### A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.



- B. Pre-tensioned Pipe Labels: Pre-coiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe with or without a fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

## 2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½-inch numbers.
  - 1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on a 8-1/2 x 11-inch bonded paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, close, or modulating), and variations for identification. Mark valves for emergency shut-off and similar special uses.
- C. Valve-tag schedule shall be included in operation and maintenance data and shall be laminated and mounted in the mechanical room and filter room.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.
- C. Equipment above ceilings:
  - 1. Install an adhesive label attached to the ceiling grid marked with the respective equipment plan tag designation.

### 3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where new and existing piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:
  - 1. Heating Water and Natural Gas Piping:
    - a. Background Color: Yellow.
    - b. Letter Color: Black.
    - c. Flow Directional Arrows: Show flow direction.
  - 2. Refrigeration Piping:
    - a. Background Color: Yellow.
    - b. Letter Color: Black.
    - c. Flow Directional Arrows: Show flow direction

### 3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units. List tagged valves is a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - a. Heating Hot Water & Natural Gas: 1-1/2 inch round.
  - 2. Valve-Tag Color:
    - a. Natural
  - 3. Letter Color: stamped only allowed.

END OF SECTION 230553

## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
  - a. Constant-volume air systems.
  - b. Variable-air-volume systems.
2. Balancing Hydronic Piping Systems:
  - a. Constant-flow hydronic systems.
  - b. Variable-flow hydronic systems.

#### 1.2 SCOPE

A. Equipment and systems to be tested and balanced includes:

1. All equipment and systems listed on the mechanical drawings.
2. Domestic hot water system as outlined on the plumbing drawings.

#### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

#### 1.4 SUBMITTALS

- A. Strategies and Procedures Plan: Within 100 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.

#### 1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB Firm certified by NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB or TABB.
  2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB or TABB as a TAB technician.
- B. Certify TAB field data reports and perform the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."
- F. Approved Balance Contractors
1. Balancing Professionals, Rapid City, South Dakota.
  2. Big Horn Corporation, Billings, Montana.

## 1.6 COORDINATION

- A. Coordinate the 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.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## PART 2 - EXECUTION

### 2.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. TAB contractor shall conduct a site inspection with the mechanical contractor at least fourteen (14) days prior to beginning the testing and balancing effort to review project conditions and readiness. TAB contractor shall develop and submit a list of installation deficiencies that would preclude the TAB contractor from executing the TAB of systems and equipment. This list shall be submitted to the mechanical engineer and the

mechanical contractor for review. The mechanical contractor shall address and correct these deficiencies.

- C. An onsite coordination meeting with the mechanical engineer, mechanical contractor, TAB contractor, and temperature control contractor shall take place at least five (5) days prior to beginning the testing and balancing efforts.
- D. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- E. Examine the approved submittals for HVAC systems and equipment.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Report deficiencies discovered before and during performance of TAB procedures. Record default set points if different from indicated values.

## 2.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures, draft test reports reflecting design conditions of equipment, terminal units, and terminal outlets and inlets, and submit to the mechanical engineer.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

- C. Prior to conducting any testing and balancing work, setup a meeting with the mechanical contractor and mechanical engineer to review testing and balancing procedures, and work schedule.

## 2.3 TEMPERATURE CONTROLS

- A. Inspect all temperature control systems for proper sequence of operation, completeness and approximate calibration. Report any deficiencies to the mechanical contractor and temperature control contractor.
- B. TAB Contractor shall coordinate balancing of the system with the Temperature Controls Contractor prior to start of Testing and Balancing to coordinate use of Temperature Control System and Technicians.
- C. All balancing shall be performed, coordinated, and scheduled with the Temperature Controls Contractor. Refer to Specification Section 230993 for additional requirements.

## 2.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 2.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections and functioning.
- I. Check for proper sealing of air-handling-unit components.
- J. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

## 2.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.
  - 4. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 5. Obtain approval from the Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.
- C. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers.

## 2.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
  1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses. Record this value and communicate to the temperature control's contractor to establish the system's operating pressure set-point for the temperature control system.
  3. Measure total system airflow. Adjust to within indicated airflow.
  4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
  6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
  7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
  8. Record final fan-performance data.



## 2.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  - 1. Open all manual valves for maximum flow.
  - 2. Check liquid level in expansion tank.
  - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
  - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
  - 5. Set system controls so automatic valves are wide open to heat exchangers.
  - 6. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
  - 7. Check air vents for a forceful liquid flow exiting from vents when manually operated.

## 2.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC, DOMESTIC HOT WATER RECIRCULATION SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
  - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - a. If impeller sizes must be adjusted to achieve pump performance, contact Engineer.
  - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
    - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
  - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  - 4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Record manufacturer's valve nameplate (or tagged) data.

- D. Set calibrated balancing valves, if installed, at calculated presettings.
  - 1. Record settings and mark balancing devices.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Check settings and operation of each safety valve. Record settings.

## 2.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.
- B. Select the hydronic coil that is most critical to the distribution system. Adjust the system static pressure by varying the pump's respective variable frequency drive so the pressure differential across the critical coil assembly satisfies the coil's required flow rate. Record the variable frequency drive value and the respective pressure and communicate these values to the temperature control's contractor to establish the system's operating parameters for the temperature control system.

## 2.11 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

## 2.12 PROCEDURE FOR THE VARIABLE-FLOW HYDRONIC PUMPS.

- A. Balance system with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals.
- B. In collaboration with the Temperature Control Contractor perform, test, and record the following:
  1. With one (1) pump in operation, and the other off:
    - a. Adjust the pump's variable frequency drive to achieve the initial operating differential pressure set-point. The set-point shall be the minimum differential pressure set-point required to provide the scheduled flowrate through the heating hot water coils.
    - b. Measure, Determine, and Record the following:
      - 1) Pump TDH:
        - a) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        - b) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        - c) Convert pressure to head and correct for differences in gage heights.
        - d) With valves open, read pump TDH.
        - e) Record TDH.
      - 2) Pump Flow Rate:
        - a) Using the manufacture's pump specific flow curve and the measured TDH, determine and record the pump's concurrent flow rate.
        - b) Record the flow rate.
      - 3) Final pumps' operating data, TDH, volts, amps, and static profile.
    2. Repeat the above steps for the other pump with the previous tested pump in the off position.
    3. Record the final differential pressure operating set-point.

## 2.13 PROCEDURES FOR AIR HANDLING UNIT CONDENSING SECTIONS

- A. Data shall be obtained with entering air temperatures near the scheduled entering conditions.
- B. Verify proper rotation of fans.
- C. Measure entering- and leaving-air temperatures.
- D. Record compressor data.

## 2.14 PROCEDURES FOR AIR HANDLING UNIT / MAKE UP AIR UNIT COILS / FURNANCE SECTIONS

### A. Measure, adjust, and record the following data for each furnace section:

1. Data shall be obtained with the airflow rate and entering air temperatures near the scheduled entering conditions.
2. Dry-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Burner firing rate shall be 100%.

### B. Measure, adjust, and record the following data for each water coil:

1. Data shall be obtained with the airflow rate and entering air and water temperatures near the scheduled entering conditions.
2. Entering- and leaving-water temperature.
3. Water flow rate.
4. Water pressure drop.
5. Dry-bulb temperature of entering and leaving air.
6. Wet-bulb temperature of entering and leaving air for cooling coils.
7. Airflow.
8. Air pressure drop.
9. Coils fitted with autoflow valves record the following:
  - a. The valve manufacture's tagged and labeled data.
  - b. The pressure drop across the valve.

### C. Measure, adjust, and record the following data for each refrigerant coil:

1. Data shall be obtained with the airflow rate and entering air temperatures near the scheduled entering conditions.
2. Dry-bulb temperature of entering and leaving air.
3. Wet-bulb temperature of entering and leaving air.
4. Airflow.
5. Air pressure drop.
6. Refrigerant suction pressure and temperature read from the unit's packaged controls.

## 2.15 PROCEDURES FOR BOILERS

- ### A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow with the boilers operating near the scheduled entering water temperature and firing at 100%.

## 2.16 PROCEDURES FOR VAV REHEAT, CABINET UNIT HEATER, AND UNIT HEATER COILS

### A. Measure, adjust, and record the following data for each water coil:

1. Validate VAV box service and clearance requirements have been made and report any clearance deficiencies.
2. Data shall be obtained with the airflow rate and entering air and water temperatures near the scheduled entering conditions.
3. Entering- and leaving-water temperature.
4. Water flow rate.
5. Water pressure drop.
6. Dry-bulb temperature of entering and leaving air as displayed on the Building Management System. If terminal unit is not interfaced with the Building Management System then take physical readings at the unit.
7. Airflow rate as displayed on the Building Management System. If the terminal unit is not interfaced with the Building Management System then take physical readings at the unit.
8. Coils fitted with autoflow valves record the following:
  - a. The valve manufacture's tagged and labeled data.
  - b. The pressure drop across the valve.

## 2.17 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  2. Air Outlets and Inlets: Plus or minus 10 percent.
  3. Heating-Water Flow Rate: Plus or minus 10 percent.
  4. Domestic-Hot Water Recirculation Flow Rate: Plus or minus 10 percent.

## 2.18 REPORTING

- A. Status Reports: Report a list of deficiencies and problems found in systems being tested and balanced to the Engineer on a daily basis.

## 2.19 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  1. Pump curves.
  2. Fan curves.
  3. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
  - a. Indicated versus final performance.
  - b. Notable characteristics of systems.
  - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
  - a. Settings for outdoor-, return-, and exhaust-air dampers.
  - b. Conditions of filters.
  - c. Cooling coil, wet- and dry-bulb conditions.
  - d. Fan drive settings including settings and percentage of maximum pitch diameter.
  - e. Settings for supply-air, static-pressure controller.
  - f. Other system operating conditions that affect performance.

## 2.20 ADDITIONAL TESTS

- A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.
- B. The TAB Contractor shall include, after completing and submitting the final report, one (1) days of follow-up testing within the project's warranty period to make any Owner or Engineer directed balance changes or modifications.

END OF SECTION 230593

## SECTION 230700 - INSULATION PIPING AND DUCTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Insulation Materials:
  - a. Flexible elastomeric.
  - b. Mineral fiber.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied jackets.
8. Tapes.
9. Securements.
10. Corner angles.
11. Acoustical duct lagging.

##### B. Related Sections:

1. Division 23 Section "Metal Ducts" for duct liners.

#### 1.2 SUBMITTALS

- ##### A. Product Data:
- For each type of product indicated.

#### 1.3 QUALITY ASSURANCE

- ##### A. Fire-Test-Response Characteristics:
- Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; All-Service Duct Wrap.
- H. Mineral-Fiber, Preformed Pipe Insulation:
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.



- c. Knauf Insulation; 1000 Pipe Insulation.
  - d. Manson Insulation Inc.; Alley-K.
  - e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. CertainTeed Corp.; Commercial Board.
  - b. Johns Manville; 800 Series Spin-Glas.
  - c. Knauf Insulation; Insulation Board.
  - d. Manson Insulation Inc.; AK Board.
  - e. Owens Corning; Fiberglas 700 Series.
- J. Mineral-Fiber Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. CertainTeed Corp.; CrimpWrap.
  - b. Johns Manville; MicroFlex.
  - c. Knauf Insulation; Pipe and Tank Insulation.
  - d. Manson Insulation Inc.; AK Flex.
  - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Insulco, Division of MFS, Inc.; SmoothKote.
  - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
  - c. Rock Wool Manufacturing Company; Delta One Shot.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA Inc.; Aero seal.
    - b. Armacell LCC; 520 Adhesive.
    - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    - d. RBX Corporation; Rubatex Contact Adhesive.
  - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Chemical Company (The); 739, Dow Silicone.
    - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.

- d. Speedline Corporation; Speedline Vinyl Adhesive.
- 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-35.
    - b. Design Polymeric; DP 3040.
    - c. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - d. ITW TACC, Division of Illinois Tool Works; CB-50.
    - e. Marathon Industries, Inc.; 590.
    - f. Mon-Eco Industries, Inc.; 55-40.
    - g. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-10.
    - b. Design Polymeric; DP 5050.
    - c. Foster Products Corporation, H. B. Fuller Company; 35-00.
    - d. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - e. Marathon Industries, Inc.; 550.
    - f. Mon-Eco Industries, Inc.; 55-50.
    - g. Vimasco Corporation; WC-1/WC-5.
  - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 200 deg F.
  - 4. Solids Content: 63 percent by volume and 73 percent by weight.

5. Color: White.

## 2.5 SEALANTS

### A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products, Division of ITW; CP-76-8.
  - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
  - c. Marathon Industries, Inc.; 405.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.6 FACTORY-APPLIED JACKETS

### A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; Metal Jacketing Systems.
    - b. PABCO Metals Corporation; Surefit.
    - c. RPR Products, Inc.; Insul-Mate.
  - 2. Factory cut and rolled to size.
  - 3. Finish and thickness are indicated in field-applied jacket schedules.
  - 4. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  - 5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  - 6. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.
    - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.
    - d. Flange and union covers.
    - e. End caps.
    - f. Beveled collars.
    - g. Valve covers.
    - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available
- D. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: White.
  - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

## 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    - b. Compac Corp.; 104 and 105.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corp.; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    - b. Compac Corp.; 130.

- c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
  - d. Venture Tape; 1506 CW NS.
- 2. Width: 2 inches.
  - 3. Thickness: 6 mils.
  - 4. Adhesion: 64 ounces force/inch in width.
  - 5. Elongation: 500 percent.
  - 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corp.; 120.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Venture Tape; 3520 CW.
  - 2. Width: 2 inches.
  - 3. Thickness: 3.7 mils.
  - 4. Adhesion: 100 ounces force/inch in width.
  - 5. Elongation: 5 percent.
  - 6. Tensile Strength: 34 lbf/inch in width.

## 2.9 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products; Bands.
    - b. PABCO Metals Corporation; Bands.
    - c. RPR Products, Inc.; Bands.
- B. Insulation Pins and Hangers:
- 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      - 2) GEMCO; Perforated Base.
      - 3) Midwest Fasteners, Inc.; Spindle.

- b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc.; RC-150.
    - 2) GEMCO; R-150.
    - 3) Midwest Fasteners, Inc.; WA-150.
    - 4) Nelson Stud Welding; Speed Clips.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

## 2.10 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

## 2.11 ACOUSTICAL DUCT LAGGING

- A. Duct Lagging.
  - 1. Product Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Sound Seal.
    - b. Or other prior approved equal.
  - 2. Basis Of Design Product: Sound Seal B-10 LAG/QFA-3
    - a. Listings: Class A (or 1) Per ASTM E84
    - b. Physical Properties:
      - 1) Minimum Weight: 1.2 lb / sq.ft.
      - 2) Thickness: 1.0 inches.



- 3) Material: Reinforced foil-faced loaded vinyl noise barrier bonded to a 1" thick quilted fiberglass sound absorber.
- 4) Service Temperature: -20 to 220 deg F.
- c. Acoustical Data:
  - 1) Sound Transmission Loss (db) at respective Frequency (Hz) of 125 / 250 / 500 / 1000 / 2000 / 4000:
    - a) 18 / 18 / 23 / 30 / 39 / 46
  - 2) STC: 29

2.12 Refer to Drawing M0.1 for further description and application locations.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

### 3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- E. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies.

### 3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
  6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
  1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

### 3.8 ACOUSTICAL DUT LAGGING INSTALLATION

- A. Follow manufacturer's listed installation instruction and guidelines.
- B. Follow instructions further outlined on the mechanical drawings.
- C. Refer to the mechanical drawing for product application locations.



### 3.9 FINISHES

- A. Do not field paint aluminum or stainless-steel jackets.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each duct system.
  - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each type of equipment. For large equipment, remove only a portion adequate to determine compliance.
  - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, two locations of threaded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.11 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
  - 1. Refer to the mechanical drawings for requirements.
- B. Items Not Insulated:
  - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  - 2. Factory-insulated flexible ducts.
  - 3. Factory-insulated plenums and casings.
  - 4. Flexible connectors.
  - 5. Vibration-control devices.
  - 6. Factory-insulated access panels and doors.

### 3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Supply-Air, Exhaust-Air and Outside-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- B. Refer to the mechanical drawings for additional requirements.

### 3.13 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Air Separator AS-1 insulation shall be the following:
  - 1. Mineral-Fiber Tank Insulation: 2 inch thick.

### 3.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Underground piping.
  - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.15 INDOOR PIPING INSULATION SCHEDULE

- A. All Heating-Hot-Water Supply and Return, 200 Deg F and below piping: Insulation shall be the following:
  - 1. Mineral-Fiber, Preformed Pipe, Type I: 1-inch thick for piping 1-1/2" and smaller and 2" thick for piping 2" and larger.
- B. Boiler Combustion-Air Duct and Plenum Insulation: Insulation shall be the following:
  - 1. Flexible Elastomeric: 1-inch thick.
- C. Refrigeration Piping – Liquid and Suction: Insulation shall be the following:
  - 1. Flexible Elastomeric: 1-inch thick.

- D. Refer to the mechanical drawings for additional requirements.

### 3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Insulated Piping In Mechanical Rooms, Exposed:
  - 1. PVC: 20 mils thick.
- D. Air Separator AS-1:
  - 1. PVC: 20 mils thick.

### 3.17 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigeration Piping – Liquid and Suction: Insulation shall be the following:
  - 1. Flexible Elastomeric: 2-inch thick.

### 3.18 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Refrigeration Piping, Exposed:
  - 1. Aluminum, stucco embossed: 0.024 thick.

END OF SECTION 230700

## SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. A new web-based accessible, Direct Digital Control (DDC) temperature control system using BACnet communication protocol shall be provided for this project. The temperature control contractor shall furnish and install all necessary labor, equipment, devices, wiring, and services for a fully functional temperature control system.
- B. All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.
- C. The BMS contractor shall refer to all plans and specifications for further instructions, details, and requirements not listed in this specification.
- D. This Section includes control equipment for the new HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- E. See Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.
- F. The electrical contractor is responsible for thermostat rough-ins, coordinate with the electrical contractor. Temperature control contractor is responsible for all other control system wiring rough-in and conduit.
- G. Front end graphical user interface (GUI) shall be connected/accessible via the Owners IP address. Provide front end GUI with separate levels of access restriction for viewing only, temperature setpoint control and for operational modifications. Coordinate with the Owner for specific requirements.
- H. The new temperature control system shall interface with the Owners existing respective Johnson Controls or Long Building Technologies server. Coordinate interface with the Owner and the existing respective server.
- I. A space temperature sensor shall be installed in the water riser room located in the new Stadium Pavilion Building to monitor the space temperature on the new BMS. An alarm shall be generated on the BMS if the space temperature falls below 50 F (adjustable).
- J. See Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.
- K. See Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for requirements that relate to this Section.
- L. See Division 23 Section "Condensing Boilers" for requirements that relate to this Section.

- M. See Division 23 Section “Packaged Outdoor Heat Wheel Energy Recovery Units” for requirements that relate to this Section.
- N. See Division 23 Section “Packaged Rooftop Air Conditioning Units” for requirements that relate to this Section.

## 1.2 DEFINITIONS

### A. Standard

- 1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
- 2. AHU: Air Handling Unit
- 3. BACnet: Building Automation Controls Network
- 4. BMS: Building Management System
- 5. DDC: Direct Digital Control
- 6. EIA: Electronic Industries Alliance
- 7. GUI: Graphical User Interface
- 8. HVAC: Heating, Ventilation, and Air Conditioning
- 9. IEEE: Institute Electrical Electronic Engineers
- 10. MER: Mechanical Equipment Room
- 11. PID: Proportional, Integral, Derivative
- 12. VAV: Variable Air Volume Box

### B. Communications and protocols

- 1. ARP: Address Resolution Protocol
- 2. CORBA: Common Object Request Broker Architecture
- 3. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
- 4. DDE: Dynamic Data Exchange
- 5. HTTP: Hyper Text Transfer Protocol
- 6. IIOP: Internet Inter-ORB Protocol
- 7. LAN: Local Area Network
- 8. MS/TP: Master Slave Token Passing
- 9. ODBC: Open DataBase Connectivity
- 10. ORB: Object Request Broker
- 11. SQL: Structured Query Language
- 12. UDP: User Datagram Protocol
- 13. XML: eXtensible Markup Language

### C. Controllers

- 1. AAC: Advanced Application Controller
- 2. UEC: Unitary Equipment Controller
- 3. UNC: Universal Network Controller
- 4. VAVDDC: Variable Air Volume Direct Digital Controller

### 1.3 SYSTEM DESCRIPTION Ethernet (IEEE 802.3), peer-to-peer CSMA/CD

- A. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing a high speed peer to peer network of interoperable Direct Digital Controls (DDC), Graphical User Interface (GUI) with color graphic displays available on at least 64 client computers, and electronic interfaces and actuation devices, as shown on the drawings and as described herein.
- B. The Local Area Network (LAN) shall be either a 10 or 100 Mbps Ethernet network supporting BACnet, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Universal Network Controllers (UNCs), user workstations and a local host computer system.
- C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.
- D. The system will consist of an architecture that utilizes a MS/TP selectable 9.6-76.8 K9600 Baud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2001, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The AAC shall have a MS/TP bus that is capable of supporting up to 127 UEC's or VAVDDC's without the addition of repeaters. The ANSI / ASHRAE™ Standard 135-2001, BACnet protocol are required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.
- E. The software tools required to network manage the ANSI / ASHRAE™ Standard 135-2001, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet/Ethernet IP or MS/TP.
- F. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein.
  - 1. The supplied system must incorporate the ability to access all data without requiring proprietary operator interface and configuration programs.
  - 2. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage.
    - a. This data shall reside on a supplier-installed server for all database access.
    - b. Systems requiring proprietary database and user interface programs shall not be acceptable.

- c. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
    - d. Systems employing a "flat" single tiered architecture shall not be acceptable.
  - G. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the ABS Control Contractors. The BMS Control Contractors shall have a minimum of 5 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the BMS Control Contractors and shall not be subcontracted. The control contractor shall have an in place support facility within 150 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.
  - H. UPS (uninterruptible power supply) shall be installed at each control panel. Size for 25% spare capacity with sufficient capacity to allow emergency power for a minimum of 15-minutes.
- 1.4 INSTALLATION OF PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION (Unless noted otherwise on the Drawings).
- A. Hydronic Piping:
    - 1. Control Valves.
    - 2. Flow Switches.
    - 3. Temperature Sensor Wells and Sockets.
- 1.5 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION (Unless otherwise noted on the Drawings).
- A. See equipment specifications and sequence of operations.
- 1.6 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION (Unless otherwise noted on the Drawings).
- A. Air Handling Units
  - B. Boiler Plant
  - C. Heating Hot Water Pumps
  - D. VAV Terminal Units
  - E. Exhaust Fans

- F. Unit Heaters
- G. Cabinet Unit Heaters
- H. Domestic Water Pumps
- I. Fire Alarm System.
  - 1. Duct Mounted Smoke Detectors.
- J. Other Mechanical Equipment listed on the Mechanical Drawings.

#### 1.7 SUBMITTALS.

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  - 1. Each control device labeled with setting or adjustable range of control.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, and method of field assembly, components, and location and size of each field connection.
  - 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  - 3. Details of control panel faces, including controls, instruments, and labeling.
  - 4. Written description of sequence of operation.
  - 5. DDC System hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
  - 6. Control System Software: Schematic diagrams, written descriptions, and points list.
  - 7. Schedule of valves including close-off and flow characteristics.
  - 8. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
  - 9. Listing of connected data points, including connected control unit and input device.
  - 10. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
  - 11. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- C. PIC/BIBB statement clarifying which BACnet objects and services are supported by each controller.
- D. ANSI / ASHRAE™ Standard 135-2001, BACnet PIC/BIBB Statement: Proof of Compliance Level 3 or higher is required to protect building owner by reducing future maintenance and expansion costs.



- E. Software and Firmware Operational Documentation: Include the following:
  - 1. Engineering, Installation, Operation and Maintenance manuals.
  - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.
  - 5. Licenses, guarantee, and warranty documents for all equipment and systems.
- F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- H. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

## 1.8 RECORD DOCUMENTATION:

- A. Operation and Maintenance Manuals
  - 1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on a USB flash drive, and include the following for the BMS provided:
    - a. Table of contents.
    - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
    - c. Manufacturers product data sheets or catalog pages for all products including software.
    - d. System Operator's manuals.
    - e. Archive copy of all site-specific databases and sequences.
    - f. BMS network diagrams.
    - g. Interfaces to all third-party products and work by other trades.
  - 2. The Operation and Maintenance Manual shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

## 1.9 QUALITY ASSURANCE.

- A. Bids by wholesalers, distributors, mechanical contractors, ABCS, ACS, and non-franchised contractors shall not be acceptable.

- B. The system manufacturer shall, as a minimum, manufacture and supply the Variable Air Volume Direct Digital Controller, Network Controller, Unitary Equipment Controller, Advanced Application Controller, Graphical User Interface, damper actuators, and valve actuator assemblies.
- C. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer's local field office.
- D. The Building Management System contractor shall have a full service facility within 150 miles of the project that is staffed with engineers trained in Integrating Interoperable Systems and technicians fully capable of providing routine emergency maintenance service on all system components.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
- G. Comply with National Electric Code, UL-916 Energy Management Systems, ULC, FCC Part 15, subpart J, Class B Computing Devices.

#### 1.10 DELIVERY, STORAGE AND HANDLING.

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

#### 1.11 COORDINATION.

- A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment from other divisions including "Panelboards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.
- C. Coordinate supply of conditioned electrical circuits for control units.
- D. Coordinate with the Owner's IT department on locations for UNC's, Ethernet communication cabling and TCP/IP addresses.
- E. Coordinate and provide the project's mechanical engineer remote web based access for system performance monitoring purposes. Coordinate access security level with the Owner.

## 1.12 WARRANTY AND MAINTENANCE.

- A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.
- B. Maintain an adequate supply of materials within 150 miles of the Project site such that replacement of key parts and labor support, including programming.
- C. During the warranty period, if system or equipment issues arise, the Contractor shall submit a warranty report to the Architect/Engineer identifying the issue and what was done to correct the issue. The warranty report shall identify the date the issue was discovered, when the issue was resolved, and the key personal involved in resolving the issue.

## 1.13 OWNERSHIP OF PROPRIETARY MATERIAL.

- A. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

## PART 2 - PRODUCTS

### 2.1 APPROVED MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
  - 1. Electric Components
    - a. Distech Controls
    - b. Johnson Controls
  - 2. Electronic Components
    - a. Tridium and Distech Controls

- b. Johnson Controls
- 3. Direct Digital Control Systems and Approved Installing Contractors:
  - a. Tridium and Distech Controls installed by Long Building Technologies.
  - b. Johnson Controls installed by Johnson Controls.

## 2.2 DDC EQUIPMENT

### A. GUI Server Application Software: Include the following:

1. Input/output capability from on-site or web browser operator station for monitoring and controlling all of the points listed in the input/output point list. The operator shall be able to monitor and access all points by means of clear concise English names without having to understand or reference hardware point locations or controller programs.
2. Operating System: The GUI shall run on Microsoft Windows 7, or later.
3. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
4. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
  - a. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
  - b. Primary project graphic screen shall display the facility's floor plan showing the respective space temperatures and set-point temperatures, and general area locations of mechanical plants and equipment, and terminal units. BMS contractor shall obtain the floor plan in an AutoCAD dwg or dxf file format from the engineer.
  - c. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
  - d. Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
  - e. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
    - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
    - 2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
7. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
  - a. Create, delete or modify control strategies.
  - b. Add/delete objects to the system.
  - c. Tune control loops through the adjustment of control loop parameters.
  - d. Enable or disable control strategies.
  - e. Generate hard copy records or control strategies on a printer.
  - f. Select points to be alarmable and define the alarm state.
  - g. Select points to be trended over a period of time and initiate the recording of values automatically.
8. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
9. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
10. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
11. Alarm Console
  - a. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
  - b. When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

## B. Web Browser Clients

1. The system shall be capable of supporting 64 clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, are only acceptable if 64 licensed copies of the client machine software are provided, installed, and tested.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall only be acceptable if 64 workstations or workstation hardware upgrades are provided.
3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
4. The Web browser client shall support at a minimum, the following functions:
  - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
  - b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
  - c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
  - d. Storage of the graphical screens shall be in the Building Control Units (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
  - e. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
  - f. User’s shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    - 1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
      - a) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
      - b) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
    - 2) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
    - 3) View logs and charts
    - 4) View and acknowledge alarms
  - g. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific

h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

- #### D. Control Units General:

- ### E. Universal Network Controllers (UNC)

- ## Instrumentation and Control for HVAC

- a. Calendar functions
  - b. Scheduling
  - c. Trending
  - d. Alarm monitoring and routing
  - e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
2. The Universal Network Controller Type 1 must provide the following hardware features as a minimum:
- a. One Ethernet Port – 10/100 Mbps
  - b. Two RS-232 ports
  - c. Two RS-RS485 ports electrically isolated
  - d. One LonWorks Interface Port – 78KB FTT-10A with Weidmuller connector
  - e. Power supply 24 VAC or 24 VDC
  - f. Battery Backup
  - g. Real-time clock
  - h. Processor @ 200 MHz or greater
  - i. Java Virtual Machine
  - j. 40 Mb flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
  - k. 128 Mb Ram or greater
3. The UNC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the UNC shall be an ODBC compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
4. The UNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 64 simultaneous users.
5. Event Alarm Notification and actions
- a. The UNC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
  - b. The UNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
  - c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
    - 1) To alarm
    - 2) Return to normal
    - 3) To fault
  - d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
  - e. Provide timed (schedule) routing of alarms by class, object, group, or node.
  - f. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.



- g. Control equipment and network failures shall be treated as alarms and annunciated.
- h. Alarms shall be annunciated in any of the following manners as defined by the user:
  - 1) Screen message text
  - 2) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
    - a) Day of week
    - b) Time of day
    - c) Recipient
  - 3) Pagers via paging services that initiate a page on receipt of email message
  - 4) Graphic with flashing alarm object(s)
  - 5) Printed message, routed directly to a dedicated alarm printer
- i. The following shall be recorded by the UNC for each alarm (at a minimum):
  - 1) Time and date
  - 2) Location (building, floor, zone, office number, etc.)
  - 3) Equipment (air handler #, accessway, etc.)
  - 4) Acknowledge time, date, and user who issued acknowledgement.
  - 5) Number of occurrences since last acknowledgement.
- j. Alarm actions may be initiated by user-defined programmable objects created for that purpose.
- k. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- l. A log of all alarms shall be maintained by the UNC and/or a server (if configured in the system) and shall be available for review by the user.
- m. Provide a "query" feature to allow review of specific alarms by user defined parameters.
- n. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- o. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

## 6. Data Collection and Storage

- a. The UNC shall have the ability to collect data for any property of any object and store this data for future use.
- b. The data collection shall be performed by log objects, resident in the UNC that shall have, at a minimum, the following configurable properties:
  - 1) Designating the log as interval or deviation.
  - 2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

- 3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
  - 4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
  - 5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
7. All log data shall be stored in a relational database in the UNC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
8. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
9. All log data shall be available to the user in the following data formats:
  - a. HTML
  - b. XML
  - c. Plain Text
  - d. Comma or tab separated values
10. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SQL Server®, Oracle 8i or Express®, Hyperion Solutions™ SQL Server.
11. The UNC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other UNC on the network. Provide the ability to configure the following archiving properties, at a minimum:
  - a. Archive on time of day
  - b. Archive on user-defined number of data stores in the log (buffer size)
  - c. Archive when log has reached its user-defined capacity of data stores
  - d. Provide ability to clear logs once archived
12. AUDIT LOG
  - a. Provide and maintain an Audit Log that tracks all activities performed on the UNC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the UNC), to another UNC on the network, or to a server. For each log entry, provide the following data:
    - 1) Time and date
    - 2) User ID
    - 3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
13. DATABASE BACKUP AND STORAGE
  - a. The UNC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

- b. Copies of the current database and, at the most recently saved database shall be stored in the UNC. The age of the most recently saved database is dependent on the user-defined database save interval.
- c. The UNC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

F. Advanced Application Controller (AAC):

- 1. Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications. AAC's shall be provided for large AHU's, Boiler Plant, Chiller Plant and other applications.
- 2. Units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.
- 3. The Advanced Application Controller shall have the following point count as a minimum.
  - a. 4 Digital Inputs.
    - 1) 10 pulses per second.
  - b. 12 Universal Inputs
    - 1) 0-20mA
    - 2) 0-5 VDC
    - 3) Balco Sensors
    - 4) Platinum Sensor
    - 5) 10K thermistor
  - c. 8 Universal Outputs
    - 1) 0-20 mA
    - 2) 12 VDC relay driver
    - 3) Individually short circuit protected
    - 4) LED indication
  - d. 8 Digital Outputs
    - 1) Triacs
    - 2) LED indication
- 4. The controller shall come with an on board regulated 20 VDC power supply rated at 100 mA.
- 5. Stand-alone mode control functions operate regardless of network status. Functions include the following:
  - a. Peer to peer primary network level communications supporting BACnet objects and services according to PIC and BIBBs statement.

- b. Automatic communications loss detection to maintain normal control functionality regardless of available networks communications.
  - c. Discrete/digital, analog, and pulse input/outputs.
  - d. Monitoring, controlling, or addressing data points.
  - e. Local energy management control strategies
  - f. Incorporate internal customizable safeties and limits to prevent third party BACnet tools from providing improper and unrealistic inputs to AAC's.
- 6. Local operator interface port provides for download from and connection to portable workstation.
- 7. Communication:
  - a. The Advanced Application Controller shall communicate via the Primary Controller Network between BMS Controllers and other BACnet devices.
  - b. Communication shall be peer-peer.
  - c. AAC's shall communicate with and other BACnet devices at a baud rate selectable between 9.6 and 76.8 Kbaud using MS/TP communications protocol.
  - d. AAC shall communicate with the UNC using:
    - 1) RS-485 trunk with a baud rate selectable between 9.6 and 76.8 Kbaud using MSTP communications protocol.
    - 2) A Ethernet trunk 10/100 Mb using BACnet IP.

G. Unitary Equipment Controller Units:

- 1. Single board construction comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control and unitary applications. UECs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, Rooftop Units, and other applications as shown on the drawings. To assure complete interoperability, all UEC's firmware shall support all BACnet objects and services as called out in the PIC and BIBBs statement
- 2. The Unitary Equipment Controller shall have the following point count as a minimum.
  - a. 6 Universal Inputs
    - 1) 0-20mA
    - 2) 0-5 VDC
    - 3) Balco Sensors
    - 4) Platinum Sensor
    - 5) 10K thermistor
  - b. 4 Analog Outputs
    - 1) 0-20 mA
    - 2) 0-5/10 VDC
    - 3) Individually short circuit protected
  - c. 8 Digital Outputs
    - 1) Triacs

## 2) LED indication

3. Units monitor or control each input/output point; process information; and download from the operator station.
4. Stand-alone mode control functions operate regardless of network status. Functions include the following:
  - a. Peer to peer primary network level communications with automatic communications loss detection to maintain normal control functionality regardless of available network communications.
  - b. Discrete/digital, analog, and pulse input/output.
  - c. Monitoring, controlling, or addressing data points.
  - d. Appropriate BACnet Objects for specific unitary applications.
5. Local operator interface port located on UEC and UEC sensor provides for download from or upload to portable workstation. All bus devices shall be accessible from either port.
6. Communication: UEC's shall communicate with the UNC and ACC at a baud rate selectable of 9.6-76.8 Kbaud utilizing MS/TP.
7. UEC units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, counters, interlocks, compare, limit, and alarms.
8. All UEC Controller setpoints shall be digital display setpoints with dual setpoint limits (integral hard limits which the user cannot exceed above and below and independent soft limits which are hidden from the user). All digital setpoints shall be network retentive after power outages and after replacement of sensor.

## H. UEC Room Sensor

1. The UEC Sensor shall provide room temperature value to the UEC.
2. Each UEC will support a minimum of two room sensors.
3. The UEC Sensor shall connect directly to the ASC and shall not utilize any of the I/O points of the controller.
4. The UEC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.
5. The UEC Sensor shall provide a communications jack for connection to the MS/TP communication trunk to which the UEC controller is connected.
6. The UEC Sensor, the connected controller, and all other devices on the MS/TP bus shall be accessible by the Portable Engineering Station.
7. The UEC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering.
8. The UEC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering.
9. The UEC Sensor shall be supplied in the following manner, unless otherwise noted:
  - a. LCD display for showing (typically) the current temperature.
  - b. Tenant override to allow timed override of unoccupied to occupied mode of operation.
  - c. LED indication of override state
  - d. Up/Down keys to allow adjustment of the current setpoint

- e. User interface with the UEC Sensor shall be provided as a configurable function, and shall offer password protection for access to network variable editing.
- f. ASHRAE 95 compliance (LCD display and sub-base functionality)
- g. The room sensor shall provide access to additional diagnostic data from a sensor-user keypad request. This Diagnostic mode is displayed on the LCD screens and includes separate displays for the controllers:
  - 1) Subnet and Node Address
  - 2) Errors
  - 3) Alarms
  - 4) Temperature Offset

I. VAV Controller Functionality (VAVDDC).

- 1. Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The VAVDDC shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. All input/output signals shall be directly hardwired to the VAVDDC controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the ASC. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the ASC sensor or GP tool connected at the wall sensor location.
- 2. Shall provide BACnet object and service support to provide BAS integration and optimum use of network bandwidth,
- 3. The VAVDDC control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components. The VAVDDC shall provide internal differential pressure transducer for pressure independent applications with an accuracy of  $\pm 5\%$ . Flow through transducers requiring filter maintenance are not acceptable. The VAVDDC shall provide zone control accuracy equal to or better than  $\pm 1$  degree F. Systems providing control accuracies greater than  $\pm 1$  degree F are not acceptable. With the submittal package, contractor shall provide performance data that verifies control accuracy of the VAVDDC.
- 4. All input/output signals shall be directly hardwired to the VAVDDC. A minimum of three input points of the VAVDDC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If three universal points are not available, a minimum of three input points (each) of the dry contact, resistive and analog voltage/current types must be Triac and universal analog form. All digital outputs shall be Triac type. Devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ASC or shall be available as I/O points for other controllers throughout the network.
- 5. The BMS contractor shall field install the VAVDDC to the VAV box.

6. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The BMS contractor shall provide all reheat control valves to the mechanical contractor for mounting and piping. The FMCS contractor shall provide and install the VAV box discharge air temperature sensor and all wiring between the discharge air temperature sensor and the VAVDDC controller, the valve and VAVDDC controller and between the room sensor and the VAVDDC controller.

J. VAV Box Room Sensor

1. The VAV Box Room Sensor shall provide room temperature value to the controller.
2. The VAV Box Room Sensor shall connect directly to the controller Box and shall not utilize any of the I/O points of the controller.
3. The VAV Box Room Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.
4. The VAV Box Room Sensor shall provide a communications jack for connection to the native BACnet RS-485 communication trunk to which the ASC controller is connected.
5. The VAV Box Room Sensor, the connected controller, and all other devices on the LON bus shall be accessible by the Portable Engineering Station.
6. The VAV Box Room Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering.
7. The VAV Box Room Sensor shall allow for the customization of the color on the esthetic covering as a standard offering.
8. The VAV Box Room Sensor shall be supplied in the following manner, unless otherwise noted:
  - a. LCD display for showing the current temperature.
  - b. Tenant override to allow timed override of unoccupied to occupied mode of operation.
  - c. LED indication of override state
  - d. Up/Down keys to allow adjustment of the current setpoint
  - e. User interface with the VAV Box Sensor shall be provided as a configurable function, and shall offer password protection for access to network variable editing.
  - f. ASHRAE 95 compliance (LCD display and sub-base functionality)
  - g. The VAV Box Room Sensor shall provide access to additional diagnostic data from a sensor-user keypad request. This Diagnostic mode is displayed on the LCD screens and includes separate displays for the controllers:
    - 1) Subnet and Node Address
    - 2) Errors
    - 3) Alarms
    - 4) Temperature Offset
  - h. Room sensor accessories include the following:
    - 1) Insulating Bases: For sensors located on exterior walls.
    - 2) Sensor Guards: Where shown on the drawings.
    - 3) Adjusting Key: As required for calibration and cover screws.

K. VAVDDC –Air Balancing.

1. Through a BACnet Portable Engineering Station or the Configuration Commissioning Diagnostic Tool furnished by the BMS contractor, the VAVDDC shall support a fully prompted Air Balance sequence. The BPES or CCDT shall, when connected through the wall sensor on the Ethernet network or through a WiFi connection access the VAVDDC unit. The air balance sequence shall step the balancing contractor through the checkout and calibration of the VAVDDC. Upon completion of the balancing sequence, the flow values presented by the VAVDDC shall match those observed by the balancing contractor's measurement equipment. Additionally, upon completion of the air balance, the balance settings shall be archived for future in the VAVDDC. The CCDT shall be able to access these balance settings at any time and generate a report. The balance settings can be uploaded by either the BPES or CCDT for use if the VAVDDC requires replacement. Systems not able to provide a formatted air balance Graphical Programming Tool shall provide an individual full time during the Air-balancing process to assure full balance compliance.

L. LANs:

1. Capacity for a minimum of 64 client workstations connected to multi-user, multitasking environment with concurrent capability to access DDC network or control units.
2. Enterprise Network LAN
  - a. Media: Ethernet (IEEE 802.3), peer-to-peer CSMA/CD, operating at 10 or 100 Mbps, cable 10 Base-T, UTP-8 wire, category 5
3. Primary Controller Network LAN
4. Remote Connection
  - a. Static IP address provided by Owner's Representative for system viewing on the LAN.
  - b. Available based on Owner's Security Settings and Network Administration requirements for VPN, etc. for outside access to network.

M. Software:

1. The most current operating software available shall be utilized for the temperature control system that will serve the new facility. Provide the necessary means to integrate the most current operating software with the Owners existing front-end temperature systems and servers. Contractor shall work with the Owners IT personal as necessary to implement and use the most current operating software available for the temperature control system.
2. Controller and System HVAC Applications
  - a. Update to latest version of software at Project completion. Include and implement the following capabilities from the control units if documented by the specified sequence of operations:



- 1) Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, occupied/unoccupied setback/setup, DDC with PID, and trend logging.
- 2) HVAC Control Programs: Optimal run time, supply-air reset and system volume totaling, outdoor air damper control based on mixed air temperature calculation, and enthalpy/economizer switchover.
- 3) Boiler Control Programs: Building loop heating hot water optimization with hot water supply reset, pump equipment selection and sequencing.
- 4) Programming Application Features: Include trend point, alarm reporting, alarm lockout, weekly scheduling, staggered start, sequencing, anti-short cycling and calculated point.

## 2.3 CONTROL PANELS

- A. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
  1. Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
  2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
  3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
  4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

## 2.4 SENSORS

- A. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
  1. Resistance Temperature Detectors: Platinum, thermistor, or Balco
    - a. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5 year drift of no more than .225°F maximum error of no more than .36°F
    - b. Wire: Twisted, shielded-pair cable
    - c. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
    - d. Averaging Elements in Ducts: 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches

- long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.
  - e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
  - f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- B. Static-Pressure Transmitter: Solid state, pressure transducer with suitable range for expected input, and temperature compensated.
  - 1. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
  - 2. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
  - 3. Building Static-Pressure Range: -.1 to .1, -0.25 to 0.25, -.5 to .5, -1.0 to 1.0 IN WC., jumper selectable.
  - 4. Duct Static-Pressure Range: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10 IN WC., jumper adjustable
  - 5. Note: Static-pressure transmitters and outside air pressure pickup ports serving the buildings static pressure systems shall be coordinated and located to provide the least amount of tubing between the devices. Provide multiple outside air pressure pickup ports to reduce tubing lengths to pressure transmitters.
  - 6. Static pressure sensors manufactured by Building Automation Products, Inc. are preferred. Mamac static pressure sensors are not to be used.
- C. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
- D. Equipment operation sensors as follows:
  - 1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC
  - 2. Status Inputs for Pumps: Differential-pressure switch piped across supply and return piping with adjustable pressure-differential range of 5 to 60 psig.
  - 3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- F. Water-Flow Switches: Pressure-flow switches of bellows actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless steel or bronze paddle. For chilled water applications, provide vapor proof type.
- G. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23°F to 130°F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.

## 2.5 THERMOSTATS

- A. Room Temperature Sensor:
  - 1. Communicating room sensor providing precise temperature.

2. Dual connector ports for connection to field controller shall support both power and communication, with provision for "daisy-chain" connection, so that more than one communicating sensor can be used with a single field controller. Dual connector ports shall be female RJ45 and shall be compatible with standard Ethernet pinout T568B.
  3. Temperature Sensor:
    - a. Range: 41 deg F to 104 deg F.
    - b. Accuracy: 0.9 deg F.
    - c. Resolution: 0.18 deg F.
    - d. LED Indication for set-point offset: only in occupied type spaces; i.e. classrooms, offices, breakroom, conference rooms, media rooms, and other similar type rooms.
    - e. LED Indicator only: for corridors, vestibule, multipurpose, and other similar type rooms.
  4. Enclosure: NEMA-1
  5. Refer to the mechanical drawings for additional configuration requirements.
  6. Provide thermostat guards where noted or shown on the mechanical drawings.
- B. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
1. Bulb Length: Minimum 20 feet
  2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- C. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
1. Bulb Length: Minimum 20 feet.
  2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

## 2.6 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces).
1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
  2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  3. Spring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Damper and Valve Actuators: Direct-coupled type non hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve
1. Coupling: V-bolt and V-shaped, toothed cradle.
  2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
  4. Actuators shall have the ability to be tandem mounted.
  5. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
  6. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
  7. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
  8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  9. Temperature Rating: -22°F to 140°F.
  10. Run Time: 200 seconds open, 40 seconds closed.
  11. All actuators shall have a 5 year warranty
  12. Valves:
    - a. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
    - b. Valve and Actuators shall come from the factory fully assembled.
    - c. Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.
    - d. Proportional Signal Type:
      - 1) All air handling coils.
    - e. Floating Signal Type:
      - 1) All VAV reheat coils and terminal equipment unless otherwise noted.
13. Dampers:
- a. Size for running torque calculated as follows:
    - 1) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
    - 2) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
    - 3) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. of damper.
    - 4) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.

- 5) Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.
  - 6) Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.
- b. Spring Return Manual Override actuators shall a factory set 5 Degree Damper Preload.

## 2.7 CONTROL VALVES

- A. Control Valves: Factory fabricated by Belimo or Johnson Controls, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Spring return is required for all air handling units. Non-spring return valves shall be used for all VAV reheat coils and finned tube radiators.
- C. Globe Valves NPS 2" and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Valves shall have allowable media temperature of 20°F to 281°F to assure that the valve packing will have a long life (valves will narrower allowable media temperatures have no reserve packing capability for long term watertight seal).
- D. Globe Valves NPS 2-1/2" and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
- E. Hydronic system globe valves shall have the following characteristics:
  1. Rating: Class 125 for service at 125 psig. and 250°F operating conditions.
  2. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
    - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
    - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
  3. Sizing: 3 psig. maximum pressure drop at design flow rate.
  4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
- F. Terminal Unit Control Valves: 360 psi forged yellow brass body, nickel plated brass ball, with optimizer insert for modulating applications, blow-out resistant stem, two or three-port as indicated, and threaded ends for chilled or hot water, up to 50% glycol solutions. Actuators shall be as noted above with 5 year warranty. Spring return is required for all terminal equipment that has an outside air source. All non-spring return valves must have manual override ability built in to the actuator.

1. Rating: ANSI class IV, maximum static pressure of 250 psig., minimum fluid temperature of 20°F and maximum of 250°F operating conditions.
2. Sizing: 3 psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way and three-valves shall have equal percentage characteristics.

## 2.8 CONTROL CABLE

- A. Electronic and Fiber-Optic Cable for Control Wiring: As specified in the Electrical Specifications.
- B. LON communication cable shall be category 6.
- C. All cabling exposed in the return air plenum shall be plenum rated.
- D. All temperature control cabling shall be color coded to a single color. Temperature control cabling color shall not match any other low voltage cabling used in the facility. Temperature control cabling color shall be green, coordinate with the Owner prior to procuring.

## 2.9 VARIABLE SPEED DRIVES

- A. Temperature Control Contractor shall furnish and install the below listed variable speed drives. The electrical contractor is responsible for installing interfacing all line voltage wiring to the variable speed drives.
- B. Variable speed drives shall be Allen Bradley PowerFlex 400 Adjustable Frequency AC Drives for Fan and Pump Applications, Yaskawa Adjustable Frequency AC Drives for Fan and Pump Applications, Danfos Adjustable Frequency AC Drives for Fan and Pump Applications or ABB Adjustable Frequency AC Drives for Fan and Pump Applications. Variable frequency drives shall be provided with the following features:
  1. NEMA/UL Type 1 Enclosure.
  2. Fixed Keypad Human Interface Module.
  3. Communications: BACnet Adapter.
  4. Three (3) contactor full feature electronic bypass with disconnect.
  5. 3% Input Line Reactor.
  6. Operable and configured for a site elevation of 4,500 above sea level.
- C. Variable Speed Drive HVAC Equipment List (refer to the mechanical drawings for further detail, motor voltages, and mounting locations):
  1. Heating Hot Water Pumps HWSP-1 and HWSP-2 as scheduled on the drawings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units.

### 3.2 INSTALLATION

- A. Install equipment level and plumb.
- B. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- C. Connect and configure equipment and software to achieve sequence of operation specified.
- D. Verify location of room sensors, thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.
  - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
  - 2. Install VAVDDC discharge air temperature sensors downstream of the reheat coil at a location of full air stream mixing and as recommended by the sensor manufacture.
- E. Install guards on sensors and thermostats where indicated on the drawings.
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- I. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

### 3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Contractor shall employ or contract with qualified electricians to perform the necessary electrical work to support the temperature control project.
- B. Install raceways, boxes, and cabinets according to the electrical specifications.
- C. Install building wire and cable according to the electrical specifications
- D. Install signal and communication cable according to the electrical specifications, and industry standards and codes.

1. All exposed cabling installed in the plenum return areas shall be certified and rated for plenum applications.
  2. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  3. Install exposed cable in raceway.
  4. Install concealed cable in walls in raceway. Raceway is not required for cabling in plenum return areas.
  5. Secure and support cabling.
  6. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  7. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  8. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  9. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- G. Install variable speed drives in accordance with the manufacturer's installation guidelines and requirements.
- H. Do not install control panels, variable frequency drives, starters or other electrical devices directly below fire sprinkler, plumbing or mechanical piping, coordinate installation of electrical devices with all trades.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing to the mechanical engineer.
- B. A factory-authorized service representative specific to the variable speed drive manufacture shall perform all variable speed drive startup's and testing.
- C. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  2. Test and adjust controls and safeties.
  3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
  4. Test each point through its full operating range to verify that safety and operating control set points are as required.



5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

D. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
9. Check DDC system as follows:
  - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
  - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
  - c. Verify that spare I/O capacity has been provided.
  - d. Verify that DDC controllers are protected from power supply surges.

E. Acceptance Check Sheet

1. Prepare a check sheet that includes all points for all functions of the temperature control system as indicated in the sequence of operations included in this project.
2. Submit the check sheet to the Engineer for review and approval.
3. The engineer will use the check sheet as the basis for acceptance with the temperature control contractor.

F. VAVDDC box performance verification and documentation:

1. The temperature control contractor shall, in conjunction and coordination with Test and Balance contractor, test each VAV box for operation and correct flow. At each step, after a settling time, box air flows and damper positions will be sampled. Following the tests, a pass/fail report indicating results shall be produced. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.
2. The temperature control contractor shall issue a report based on a sampling of the VAV calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data, and shall also include graphical representations of performance.

3. The temperature control contractor shall randomly test a minimum of 35% of the VAV boxes after approximately 6-months of operation and report the findings to the engineer. The BMS Contractor shall contact the engineer prior to execution of this follow-up testing to obtain a list of VAV boxes to be tested.
- G. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
- H. An onsite temperature control review meeting shall be coordinated and scheduled with the Owner, Engineer and Contractor at substantial completion.

### 3.5 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one (1) year of date of Substantial Completion, provide up to three (3) project site visits, when requested by the Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

### 3.6 TRAINING

- A. On-site training shall be provided by a system technician who is fully knowledgeable of the specific installation details of the project. This training shall, at a minimum consist of the following:
  1. Review and understanding of the project as-built temperature control drawings.
  2. Discussion and explanation of the HVAC sequence of operation.
  3. Review of the BMS software layout and naming conventions.
  4. A walk through of the facility to identify panel and device locations.
  5. Review of device and control trouble shooting.
  6. Proficiently operate the system.
  7. Understand control system architecture and configuration.
  8. Understand DDC system components.
  9. Understand system operation, including DDC system control and optimizing routines (algorithms).
  10. Log on and off the system.
  11. Access graphics, point reports, and logs.
  12. Adjust and change system set points, time schedules, and holiday schedules.
  13. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
  14. Understand Operation and Maintenance manual.
  15. Access data from DDC controllers
- B. Training duration shall consist of eight (8) hours at substantial completion, another four (4) hours approximately six months after substantial completion, and another four (4) hours at eleven (11) months after substantial completion. Contractor shall coordinate scheduling of the training with the facility personnel. Contractor shall submit report, signed by authorized facility personnel, to the engineer documenting the completion of each training session.

END OF SECTION 230900

## SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. See Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.
- C. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades.
- D. All work in this Division shall be coordinated and provided by a single Building Management System (BMS) Contractor.

#### 1.2 NOTES

- A. All heat valves to fail in heating mode.
- B. All Temperature set points and reset schedules shall be adjustable.
- C. Provide independent set points for occupied and unoccupied modes.

#### 1.3 SCOPE

- A. It is the intent of these specifications and the contract drawings to describe the work to be performed in order to provide a complete system of temperature controls including all materials, plans, labor and accessories necessary to the successful completion and operation of the system as intended.
- B. The work to be performed shall include but not necessarily be limited to the following systems and apparatus:
  - 1. Valves and actuators, dampers, control panels, gauges and instruments, direct digital system controls and sensors, electric wiring and conduit, variable speed drives, and a workstation.
- C. All air handling units and other terminal units and equipment items noted in the sequence of operations shall be controlled by digital system controllers utilizing electronic actuators for the valves and dampers.
- D. The BMS Contractor shall field install all digital VAV box controllers and actuators. Temperature Control Contractor shall field coordinate the installation with the mechanical contractor.

- E. Temperature Control Contractor shall calibrate all instrumentation and devices prior to substantial completion and after 8-months of system operation.

#### 1.4 SCHEDULES

- A. Temperature Control Contractor shall establish all occupied, non-occupied, holiday, and summer schedules, and occupied and unoccupied (night setback) temperatures prior to final system commissioning. The temperature control contractor shall develop a schedule matrix worksheet and transmit to the owner for their input and development of the final schedule(s). The worksheet matrix shall, at a minimum list the following for each system and equipment:

1. Equipment Tag and Description.
2. Proposed Occupied Schedule
3. Proposed Un-occupied Schedule
4. Proposed Holiday Schedule
5. Proposed Summer Schedule
6. Proposed Occupied Space Temperatures
7. Proposed Unoccupied (night setback) Space Temperatures

- B. Initial Space Temperature Set-Points (adjustable)

1. Interior Office Space Conditions:
  - a. Heating:
    - 1) Unoccupied: 65 F
    - 2) Occupied: 72 F
  - b. Cooling
    - 1) Unoccupied: 85 F
    - 2) Occupied: 75 F
2. The adjustable range for occupied space temperature set-points shall follow the District's standard range of 68 F to 75 F.

#### 1.5 SEQUENCE OF OPERATIONS

- A. The following Sequence of Operations shall be used for the project.

#### 1.6 STADIUM PAVILION BUILDING

- A. A space temperature sensor shall be installed in the water riser room located in the new Stadium Pavilion Building to monitor the space temperature on the new BMS. An alarm shall be generated on the BMS if the space temperature falls below 50 F (adjustable).

## 1.7 BOILER PLANT

- A. Each condensing boiler has a capacity of 33% of the calculated maximum facility load. The boilers will be programed in a cascade sequence to operate in a lead / lag operation.
- B. Each boiler is furnished with a Lochinvar packaged Smart Touch boiler controller. The boiler controller shall be programmed by a factory authorized technician to meet the following sequence of operations. The temperature control contractor will interconnect the boilers' controllers to the BMS.
- C. The boilers are furnished with an outside air temperature sensor (to be field installed by the temperature control contractor) to serve the boiler's packaged control system. The outside air temperature sensor location shall be coordinated with the mechanical engineer prior to installation.
- D. The boilers are furnished with a heating hot water supply temperature sensor (to be field installed by the temperature control contractor) to serve the boiler's packaged control system. The heating hot water supply temperature sensor location shall be coordinated with the mechanical engineer prior to installation.
- E. The temperature control contractor shall provide and install additional temperature sensors in the hot water supply and return water piping as shown on the drawings to monitor and display the heating hot water temperature readings on the BMS. Sensor locations shall be coordinated with the mechanical engineer prior to installation.
- F. The temperature control contractor shall provide and install an additional outdoor temperature sensor to monitor and display the outdoor air temperature reading on the BMS. Sensor location shall be coordinated with the mechanical engineer prior to installation.
- G. The boilers are furnished with a BACnet protocol communication card to allow communication between the packaged boiler controls and the BMS.
- H. The boiler controller shall be programed to operate in a lead / lag cascade sequence to provide run time equalization and satisfy the established setpoints with the new boilers. The boiler controller shall modulate the boiler(s) as required to satisfy the heating load.
- I. The boiler controller shall enable the boiler when it receives a signal from the BMS when the following occurs:
  - 1. The heating hot water flow rate is proven in the primary and secondary pumps and in the boiler.
- J. Boilers shall operate on a primary outdoor air reset schedule to optimize the boiler efficiency. BMS contractor shall setup the outdoor air reset schedule and provide the set-point to the boilers.
  - 1. If the outdoor air temperature is above 77F (adjustable) the heating hot water boilers and pumps shall be disabled.
  - 2. If the outdoor air temperature is less than or equal to 75 F (adjustable). The boiler plant shall be enabled and the secondary heating hot water supply temperature setpoint shall be 110 F (adjustable).

3. If the outdoor air temperature is less than or equal to 30 deg F (adjustable), then the building loop hot water supply temperature shall be 140 deg F (adjustable).
- K. The boiler controller shall disable the boiler when it receives a signal from the BMS when the following occurs:
1. If the outdoor air temperature is above 77 F (adjustable), the boilers and all heating hot water pumps shall be disabled.
  2. The building heating hot water lead pump shall operate 2 minutes (adjustable) prior to enabling the boilers.
  3. The building heating hot water lead pump shall operate 5 minutes (adjustable) after disabling the boilers.
  4. Provide a 15 minute (adjustable) time period before re-enabling the boiler plant.
- L. Each boiler is provided with a boiler pump relay to start the associated primary boiler pump (HWPP-1 through HWPP-4). The boiler pump relay packaged with the boiler shall be utilized as it interfaces with the boiler controls and freeze protection safeties.
1. Note: Each primary boiler pump shall operate at a constant speed to maintain the boiler loop flow rate as schedule on the drawings.
- M. The secondary (building loop) variable volume hot water pumps (HWSP-1 and HWSP-2) shall be enabled by the BMS when the outdoor air temperature is less than or equal to 75 F (adjustable) to run continuously in a lead / standby alternating sequence. The lead pump shall run for 168 hours (adjustable) before alternating with the standby pump. On a loss of flow, the standby pump shall start immediately and an alarm shall be generated on the BMS. Pumps shall be locked out when outside temperature exceeds 75 F (adjustable).
1. The operating hot water pump shall vary its speed, but no less than the minimum speed permitted by the VFD manufacture, via the respective VFD to satisfy the heating hot water system's differential pressure as sensed by the system's pressure transducer station. Refer to the drawings for pressure transducer station location.
- N. The inlet and discharge of each secondary (building loop) hot water pumps shall be fitted with a BMS pressure sensor to monitor and display the pressures across each pump. Coordinate with the mechanical contractor to install the temperature control devices in the inlet and discharge piping of each secondary (building loop) pump.
- O. The BMS system shall be interfaced with boiler's controllers to monitor flame failure fault condition and alarm and the following listed items in the Monitor and Display section.
- P. Monitor and Display
1. Boiler status (read from each boiler controller).
  2. Boiler firing rate (read from each boiler controller).
  3. Boiler fault conditions (read from each boiler controller).
  4. Boiler flame signal (read from each boiler controller).
  5. Status of each boiler's primary pump: HWPP-1 thru HWPP-4.
  6. Status of each building loop pump HWSP-1 and HWSP-2 and the pump VFD speed.
  7. Inlet and discharge pressure of each building loop pump (HWSP-1 and HWSP-2).

8. System loop differential pressure set-point and operating value.
9. Temperatures of the primary (boiler loops read from each boiler controller) and secondary (building loop) heating hot water supply and return temperatures (read from the field installed temperature sensors).
10. Outdoor air temperature – read from the boiler packaged controls.
11. Outdoor air temperature – read from the BMS.
12. Heating hot water system static pressure – refer to Detail 8/M5.2 for pressure sensor location.
13. Boiler reset parameters.
14. All system set-points.
15. System alarms.
16. System overrides.

Q. Alarms

1. Boiler failure.
2. Pump failure.
3. Boiler faults as presented by the boiler packaged controls.
4. Building loop supply temperature is above 150 F for more than 10 minutes (adjustable).
5. Heating hot water system static pressure drops below 12 psig.
6. Heating hot water system static pressure rises above 45 psig.

1.8 RTU-3 & RTU-10 (PACKAGED HEATING, COOLING, AND VENTILATING HEAT RECOVERY UNITS)

A. SUPPLY AND EXHAUST FAN OPERATION:

1. Occupied Scheduled Mode (Auto-Mode):
  - a. The outside air damper shall open 100%, the return damper shall close, the energy recovery wheel, supply fan and exhaust fan shall run continuously and the exhaust fan damper shall open.
  - b. The supply fan shall modulate to maintain the discharge static pressure at set-point. The optimum set-point shall be established in conjunction with the Test and Balance contractor with the target set-point being the minimum value to meet design flow conditions (approximate setting is 1.0" W.C.). The static pressure sensor shall be located 2/3 of the way down the longest duct run. Apply trim in the sequence to optimize the duct static pressure setpoint based on VAV damper position to reduce fan energy.
  - c. The exhaust fan shall slowly modulate to maintain the building static pressure at setpoint. The static pressure set-point, adjustable, shall be negative (-) 0.02 inches w.g. (adjustable). The location of the static pressure sensor shall be coordinated with the engineer prior to installing.
  - d. Static pressure sensors manufactured by Building Automation Products, Inc. are preferred. Mamac static pressure sensors are not to be used.
  - e. Temperature Control Contractor is to minimize the length of interior static pressure tubing to improve the system measuring stability.
2. Unoccupied Scheduled Mode (Auto-Mode) (RTU-10 Only):



- a. The supply and exhaust fan shall be de-energized, the outside air and exhaust air dampers shall close and the return damper shall open 100%. If there is a call for unoccupied heating or cooling, the unit shall cycle on and off as necessary in a full recirculating mode (supply fan on, exhaust fan off, outside air and exhaust air damper closed, and return air damper 100% open) and shall control to maintain the discharge air temperature set-point.

B. DISCHARGE AIR TEMPERATURE CONTROL:

1. The BMS shall control the discharge air temperature setpoint. The discharge air temperature shall be maintained between 55°F to 75°F (adjustable) based upon the room with the highest cooling percentage strategy. The unit's modulating heating hot water coil control valve and the DX cooling shall operate to maintain the discharge air temperature setpoint.

C. DX COOLING CONTROL (Mechanical Cooling)

1. The packaged DX cooling shall be disabled when the outside air temperature is below 53°F (adjustable).
2. The cooling system shall be controlled based upon the discharge air temperature (DAT) set-point.
3. As the discharge air temperature rises above the DAT, the compressors shall modulate to maintain the DAT.
4. The compressors are to be sequenced and operated in a Cascade sequence, and with equal run-time, all established by the Temperature Control Contractor.
  - a. Safeties:
    - 1) Compressor Minimum Off Time: two (2) minutes.
    - 2) Compressor Minimum On Time: three (3) minutes.

D. ENERGY RECOVERY WHEEL

1. Defrost Control:
  - a. Unit shall include energy recovery wheel defrost control which includes a factory installed temperature sensor and timer wired to periodically stop the wheel rotation, which allows the warm exhaust air to defrost the wheel.
  - b. Contractor shall set the initial defrost control temperature setpoint and time duration of the defrost control as recommended by the rooftop unit manufacture recommendations. Setpoint and sequence duration to be adjustable.
2. Purge Mode:
  - a. When going into Occupied Mode, an optional "Purge Mode" is initiated. The fan runs with the Economizer closed, and all Cooling and Heating is de-energized. The length of the Purge Mode shall operate as recommended by the rooftop unit manufacture recommendations. Sequence duration to be adjustable.

E. MORNING WARMUP MODE:

1. A warm-up mode shall be initiated by an optimal start program to ensure the space temperature is brought up to set-point by the occupied time if all the following conditions exist:
2. The outside air temperature is below 45 F.
3. The coldest space temperature is more than 2 F below the occupied set-point.
4. During the warm-up mode, the supply fan shall run continuously, the outside air damper shall be closed, the condensing unit disabled, and the heating hot water control valve shall modulate to maintain the maximum discharge air temperature but no greater than 105 F. The warm-up mode shall be terminated when one of the following conditions exists:
  - a. The occupied time is reached.
  - b. The coldest space temperature reaches the occupied set-point.
  - c. The warmest zone is at least 2 F above set-point.

F. RTU-3 UNOCCUPIED MODE:

1. During unoccupied periods, RTU-3 shall operate continuously in the occupied mode to provide ventilation in the science chemistry labs and storage rooms. During unoccupied periods, VAV 3-4, VAV 3-5, VAV 3-9 and VAV 3-10 shall operate at the scheduled occupied airflows. All other VAV boxes shall be closed unless unoccupied space temperature conditioning is required.

G. REFRIGERANT LEAK DETECTION:

1. The RTU manufacture and temperature control contractor shall work in collaboration to achieve the below sequence of operations using the refrigerant leak detection system provide with the RTU and the temperature control system.
2. Refrigerant leak detection shall comply with UL 60335-2-40.
3. Upon refrigerant detected in the air stream or control and compressor cabinet, an alarm shall be generated on the BMS. The RTU shall be enabled if the unit is not in operation and the system shall be placed into the occupied mode. Mechanical cooling shall be disabled. All VAV boxes served by the respective RTU shall be placed into the respective VAV box full cooling airflow rate. Under no circumstance shall the RTU or respective VAV boxes operate at an airflow below 25% of the respective cooling airflow. This process shall continue until refrigerant has not been detected for a minimum of 5 minutes. After no refrigerant is detected for 5 minutes, then the system shall remain the normal operation. BMS alarm shall remain until acknowledged and cleared by the facility maintenance staff.

H. NIGHT SETBACK/NIGHT SETUP (RTU-10 Only):

1. When in the scheduled "unoccupied" mode, the outside air shall be closed, and the return air damper shall be opened. The unit shall cycle as necessary to maintain the night setback zone temperature at set point. A timed cycle differential shall prevent the unit from cycling excessively.
2. A minimum of two (2) zones shall be below the unoccupied heating setpoint before the air handling unit is enabled.
3. When enabled to maintain the night setback zone temperature at set point the following conditions shall apply:

- a. The supply fan shall control to the duct static pressure setpoint.
  - b. The discharge air temperature from the air handling unit shall be maintained between 55 F and 105 F (adjustable) based on the zone with the greatest cooling demand.
  - c. Air handling unit shall operate until all zones are above the unoccupied heating setpoint.
4. If the outdoor air temperature is below zero degree (0) Fahrenheit (adjustable), the supply fan shall be enabled and shall run at minimum speed (allowed by the VFD) to allow general circulation of building air.
5. Occupancy override switches (integral to the space sensors) shall be located in the space at location(s) designated by the Owner to temporarily activate the air handling system into an "occupied" sequence. The temporary occupied sequence will operate for a three (3) hour period (adjustable).

#### I. SAFETIES:

1. All of the safety devices are manual reset; the device that has tripped must be manually reset before restarting the air handling unit, unless otherwise noted below.
2. If a low limit temperature sensor senses a temperature below the established low-limit set point (32 F, adjustable) the supply fan and exhaust fan shall be shutdown. The low limit freeze stat shall be located downstream of the supply fan and placed in a position where the capillary sensing tube is located in a full mixed air-stream.
3. If a high static pressure switch located after the supply fan senses a discharge pressure that is greater than set point, the supply fan and exhaust fan shall be shutdown.
4. A low static pressure switch located prior to the exhaust fan senses a suction pressure that is greater than set point, the supply fan and exhaust fan shall be shutdown.
5. On a loss of power, the outside air damper shall spring closed, the exhaust damper shall close and the return air damper shall spring open.
6. Smoke Detection: Upon detection of smoke, as sensed by the smoke detector(s) installed by the electrical contractor in the exhaust air stream, the unit shall shutdown with the outside air damper shall spring closed, the exhaust damper shall close and the return air damper shall spring open. Upon detection of no smoke, the unit shall auto restart and follow the sequence of operations.

#### J. SHUTDOWN:

1. When the unit is shutdown by either a stop command or system safety the unit shall be set as follows:
  - a. Supply fan shall be off
  - b. Exhaust fan shall be off
  - c. Supply fan VFD shall be commanded to 0%
  - d. Exhaust fan VFD shall be commanded to 0%
  - e. Outside air and exhaust dampers shall close
  - f. Return air damper shall open
  - g. Modulating heating hot water control valve shall remain in control
  - h. DX Cooling shall be disabled

- i. The energy recovery wheel shall be disabled

K. MONITOR AND DISPLAY:

1. At a minimum, the following shall be monitored and displayed on the system graphics:
  - a. Supply and exhaust fan status and speed.
  - b. Heat wheel status and motor speed.
  - c. Heat wheel defrost mode set points.
  - d. Heat wheel purge set points and status.
  - e. Refrigerant leak detection status.
  - f. Damper positions.
  - g. Hydronic valve positions.
  - h. Supply Air Volume (based on a continuous volume summation of the VAV boxes).
  - i. Outdoor Air, Return Air, Mixed Air, and Discharge Air temperatures.
  - j. System Static Pressure operating set-points and operating values.
  - k. Building Area Static Pressure Set-Point and actual value.
  - l. Outdoor Air Static Pressure value.
  - m. Packaged DX cooling commanded status.
  - n. Packaged DX cooling actual operating status as sensed by a current sensor.
  - o. Packaged DX cooling compressor(s) status and speed.
  - p. Packaged DX cooling operating values and faults as presented by the unit's packaged control system.
  - q. Clogged Filter Alarm.
  - r. All system set-points.

1.9 RTU-1, 2, 4, 5, 6, 9 (VARIABLE AIR VOLUME SYSTEMS SERVING VAV BOXES)

A. SUPPLY FAN START/STOP:

1. The supply fan shall be started according to the established schedule. If the supply fan status does not match the commanded value, an alarm shall be generated. When the supply fan status indicates the fan started, the control sequence shall be enabled.

B. STATIC PRESSURE CONTROL:

1. The supply fan shall modulate to maintain the discharge static pressure at set-point. The optimum set-point shall be established in conjunction with the Test and Balance contractor with the target set-point being the minimum value to meet design flow conditions (approximate setting is 1" W.C.). The static pressure sensor shall be located approximately 2/3 of the way down the longest duct run where shown on the mechanical drawings. Final location is to be coordinated with the engineer prior to installing. Apply trim in the sequence to optimize the duct static pressure setpoint based on VAV damper position to reduce fan energy.

C. RETURN FAN TRACKING:

1. The return fan shall modulate airflow to maintain a return air static pressure at an established set-point. A static pressure sensor is to be located downstream of the return fan and upstream of the return damper.
2. The return air static pressure set-point is to be established in collaboration with the TAB contractor with the building's supply, outside air, and exhaust systems in their balanced operating state between minimum and maximum supply air volumes.

D. BUILDING PRESSURE CONTROL:

1. The air handling system shall employ a building pressurization system to maintain a positive pressure in the building area served. The system shall utilize a two (2) part system to maintain positive pressure.
  - a. Space Static Pressure Above Set-Point:
    - 1) Stage 1: The exhaust damper shall modulate open to maintain the space static pressure set-point.
    - 2) Stage 2: If the exhaust damper control does not satisfy the space static pressure set-point, the return fan speed shall gradually increase to maintain static set-point.
  - b. Space Static Pressure Below Set-Point:
    - 1) Stage 1: The exhaust damper shall modulate close to maintain the space static pressure set-point.
    - 2) Stage 2: If the exhaust damper control does not satisfy the space static pressure set-point, the return fan speed shall gradually decrease to maintain static set-point.
2. If the return air and exhaust air dampers close to 100%, then the return fan shall be commanded off.
3. A static pressure sensor shall be located uniformly in the area served by the respective air handling unit. The location of the static pressure sensor shall be coordinated with the engineer prior to installing.
4. The static pressure set-point, adjustable, shall be 0.05 inches w.g. (adjustable).
5. Temperature Control Contractor is to minimize the length of interior static pressure tubing to improve the system measuring stability.
6. Static pressure sensors manufactured by Building Automation Products, Inc. are preferred. Mamac static pressure sensors are not to be used.

E. DISCHARGE AIR CONTROL:

1. The return air and outside air dampers, the heating control valve, and the DX cooling system shall modulate in sequence to maintain the discharge air temperature at set point. The discharge air temperature shall be maintained between 55°F to 70°F (adjustable) based upon the room with the highest cooling percentage strategy.

F. DX COOLING CONTROL (Mechanical Cooling)

1. The packaged DX cooling shall be disabled when the outside air temperature is below 53°F (adjustable).
2. The cooling system shall be controlled based upon the discharge air temperature (DAT) set-point.
3. As the discharge air temperature rises above the DAT, the compressors shall modulate to maintain the DAT.

4. The compressors are to be sequenced and operated in a Cascade sequence, and with equal run-time, all established by the Temperature Control Contractor.

- a. Safeties:

- 1) Compressor Minimum Off Time: two (2) minutes.  
Compressor Minimum On Time: three (3) minutes.

G. ECONOMIZER DRY BULB SWITCHOVER:

1. When the outside air temperature is below the return air temperature from the building, the economizer shall be enabled. When the outside air temperature rises above the return air temperature from the building, the economizer shall be disabled.

H. PREHEAT CONTROL:

1. The preheat valve shall modulate to maintain the discharge air temperature at set point (adjustable).
2. Refer to Night Setback/Setup paragraph later in this section.

I. OUTDOOR AIR CONTROLS:

1. Primary Control: The outside air damper shall modulate, based on a continuous BMS mixed air temperature calculation, as required to maintain the minimum outside air volume rate as scheduled on the Drawings.
  - a. Mixed Air Temperature Calculation: 
$$\frac{[(\text{scheduled outside air rate} \times \text{outside air temperature}) + (\text{supply air volume rate} - \text{scheduled outside air rate}) \times (\text{return air temperature})]}{\text{supply air volume rate}}$$
  - 1) Note: when the outside air temperature is within 7% of the return air temperature the outside air damper's position is to be placed in a fixed position based on the damper's position immediately before the outdoor air temperature encroachment to the return air temperature. Otherwise the mixed air temperature calculation shall be used unless economizer cooling is provided.
  - b. Refer to the air handling units schedule on the mechanical drawings for each respective air handlers' minimum outside air rate.
  - c. The supply air volume rate equals the summation of the VAV air volume rates for each air handling system during actual system operation.
2. The outside air damper position shall compensate for modulating supply air system volumes between minimum and maximum operating points.
  - a. The temperature control contractor shall establish the positions with the Test & Balance contractor during the balancing phases through the use of a mixed air calculation to establish the minimum outside air setting between maximum and minimum supply air volume flow rates.
  - b. The temperature control contractor shall report the settings to the engineer and shall display the settings on the project's BMS respective air handling unit graphics.

3. The outdoor air damper shall be closed in unoccupied times, in warm up periods and cool down periods, unless outdoor air is required per the cooling sequence of operations to cool down or maintain the setback temperature.
4. Temperature sensors manufactured by Building Automation Products, Inc. are preferred. Mamac temperature sensors are not to be used.

J. FILTER STATUS

1. Send an alarm to the DDC system when the air handlers' clogged filter switch is activated.

K. SAFETIES:

1. All of the safety devices are manual reset; the device that has tripped must be manually reset before restarting the air handling unit, unless otherwise noted below.
2. If a discharge air low limit temperature sensor senses a temperature below the established low-limit set point (32 F, adjustable) the supply fan and return fan shall be shutdown. The low limit freeze stat shall be located downstream of the supply fan and placed in a position where the capillary sensing tube is located in a full mixed air-stream.
3. On an indication of a smoke detector (installed by the Electrical Contractor) served by this unit, the supply fan and return fan shall stop and the outdoor air damper shall close. Upon an indication of no smoke, the air handling unit shall auto restart and operate per the sequence of operations.
4. A low static pressure switch located prior to the return fan senses a suction pressure that is greater than set point, the supply fan and return fan shall be shutdown.
5. If a high static pressure switch located after the supply fan senses a discharge pressure that is greater than set point, the supply fan and return fan shall be shutdown.
6. If the RTU heating coil fails to provide heat, then the air handler's outside air damper shall close.
7. If the heating hot water supply temperature drops below 80 F (adjustable) while in heating mode, then the rooftop unit's outside air damper shall closed.
8. A mixed air temperature low limit safety equal to the scheduled minimum entering air temperature for the respective air handling unit heating hot water coil shall be implemented in the programming. If the mixed air temperature reaches the mixed air temperature low limit safety, the outside air damper shall gradually close until the mixed air temperature is above the mixed air temperature low limit safety.
9. A mixed air temperature high limit safety equal to the scheduled entering dry bulb air temperature for the respective air handling unit DX coil shall be implemented in the programming. If the mixed air temperature reaches the mixed air temperature high limit safety, the outside air damper shall gradually close until the mixed air temperature is below the mixed air temperature high limit safety.

L. SHUTDOWN:

1. When the unit is shutdown by either a stop command or system safety the unit shall be set as follows:
  - a. Supply fan shall be off
  - b. Return fan shall be off

- c. Supply fan VFD shall be commanded to 0%
- d. Return fan VFD shall be commanded to 0%
- e. Outside air damper shall close
- f. Return air damper shall open
- g. Preheat valve shall remain in control
- h. DX Cooling shall be disabled

M. MORNING WARMUP MODE:

- 1. A warm-up mode shall be initiated by an optimal start program to ensure the space temperature is brought up to set-point by the occupied time if all the following conditions exist:
- 2. The outside air temperature is below 45 F.
- 3. The coldest space temperature is more than 2 F below the occupied set-point.
- 4. During the warm-up mode, the supply fan shall run continuously, the outside air damper shall be closed, the condensing unit disabled, and the heating hot water coil control valve shall modulate to maintain the maximum discharge air temperature but no greater than 105 F. The warm-up mode shall be terminated when one of the following conditions exists:
  - a. The occupied time is reached.
  - b. The coldest space temperature reaches the occupied set-point.
  - c. The warmest zone is at least 2 F above set-point.

N. REFRIGERANT LEAK DETECTION:

- 1. The RTU manufacture and temperature control contractor shall work in collaboration to achieve the below sequence of operations using the refrigerant leak detection system provide with the RTU and the temperature control system.
- 2. Refrigerant leak detection shall comply with UL 60335-2-40.
- 3. Upon refrigerant detected in the air stream or control and compressor cabinet, an alarm shall be generated on the BMS. The RTU shall be enabled if the unit is not in operation and the system shall be placed into the occupied mode. Mechanical cooling shall be disabled. All VAV boxes served by the respective RTU shall be placed into the respective VAV box full cooling airflow rate. Under no circumstance shall the RTU or respective VAV boxes operate at an airflow below 25% of the respective cooling airflow. This process shall continue until refrigerant has not been detected for a minimum of 5 minutes. After no refrigerant is detected for 5 minutes, then the system shall remain the normal operation. BMS alarm shall remain until acknowledged and cleared by the facility maintenance staff.

O. NIGHT SETBACK/NIGHT SETUP:

- 1. When in the scheduled "unoccupied" mode, the outside air shall be closed, and the return air damper shall be opened. The unit shall cycle as necessary to maintain the night setback zone temperature at set point. A timed cycle differential shall prevent the unit from cycling excessively.
- 2. A minimum of two (2) zones shall be below the unoccupied heating setpoint before the air handling unit is enabled.
- 3. When enabled to maintain the night setback zone temperature at set point the following conditions shall apply:



- a. The supply fan shall control to the duct static pressure setpoint.
  - b. The discharge air temperature from the air handling unit shall be maintained between 55 F and 105 F (adjustable) based on the zone with the greatest cooling demand.
  - c. Air handling unit shall operate until all zones are above the unoccupied heating setpoint.
- 4. If the outside air temperature is below 45 degrees Fahrenheit (adjustable), the hot water valve shall be at a position to allow continuous flow through the heating coil when the rooftop unit is cycled off to maintain a mixed air temperature of 65 F.
  - 5. If the outdoor air temperature is below zero degree (0) Fahrenheit (adjustable), the supply fan shall be enabled and shall run at minimum speed (allowed by the VFD) to allow general circulation of building air.
  - 6. Occupancy override switches (integral to the space sensors) shall be located in the space at location(s) designated by the Owner to temporarily activate the air handling system into an "occupied" sequence. The temporary occupied sequence will operate for a three (3) hour period (adjustable).

P. MONITOR AND DISPLAY:

- 1. At a minimum, the following shall be monitored and displayed on the system graphics:
  - a. Supply fan status and speed.
  - b. Return fan status and speed.
  - c. Damper positions.
  - d. Hydronic coil valve position.
  - e. Refrigerant leak detection status.
  - f. Supply Air Volume (based on a continuous volume summation of the VAV boxes).
  - g. Outdoor Air, Return Air, Mixed Air, and Discharge Air temperatures.
  - h. Outdoor Air set-point volume and operating volume.
  - i. System Static Pressure operating set-points and operating values.
  - j. Building Area Static Pressure Set-Point and actual value.
  - k. Outdoor Air Static Pressure value.
  - l. Outdoor air damper control status: mixed air temperature or discharge air temperature (economizer mode).
  - m. Packaged DX cooling commanded status.
  - n. Packaged DX cooling actual operating status as sensed by a current sensor.
  - o. Packaged DX cooling compressor(s) status and speed.
  - p. Packaged DX cooling operating values and faults as presented by the unit's packaged control system.
  - q. Clogged Filter Alarm.
  - r. All system set-points.

1.10 RTU-7, 8, 11(A), 12(A) (VARIABLE AIR VOLUME SYSTEMS WITH CO2 CONTROL)

A. SUPPLY FAN START/STOP:

1. The supply fan shall be started according to the established schedule. If the supply fan status does not match the commanded value, an alarm shall be generated. When the supply fan status indicates the fan started, the control sequence shall be enabled.

**B. RETURN FAN START/STOP:**

1. When the supply fan is started a command to the return fan shall be sent. If the return fan status does not match the commanded value, an alarm shall be generated.

**C. RETURN FAN TRACKING:**

1. The return fan shall modulate airflow to maintain a return air static pressure at an established set-point. A static pressure sensor is to be located downstream of the return fan and upstream of the return damper.
2. The return air static pressure set-point is to be established in collaboration with the TAB contractor with the building's supply, outside air, and exhaust systems in their balanced operating state between minimum and maximum supply air volumes.

**D. BUILDING PRESSURE CONTROL:**

1. The air handling system shall employ a building pressurization system to maintain a positive pressure in the building area served. The system shall utilize a two (2) part system to maintain positive pressure.
  - a. Space Static Pressure Above Set-Point:
    - 1) Stage 1: The exhaust damper shall modulate open to maintain the space static pressure set-point.
    - 2) Stage 2: If the exhaust damper control does not satisfy the space static pressure set-point, the return fan speed shall gradually increase to maintain static set-point.
  - b. Space Static Pressure Below Set-Point:
    - 1) Stage 1: The exhaust damper shall modulate close to maintain the space static pressure set-point.
    - 2) Stage 2: If the exhaust damper control does not satisfy the space static pressure set-point, the return fan speed shall gradually decrease to maintain static set-point.
2. If the return air and exhaust air dampers close to 100%, then the return fan shall be commanded off.
3. A static pressure sensor shall be located uniformly in the area served by the respective air handling unit. The location of the static pressure sensor shall be coordinated with the engineer prior to installing.
4. The static pressure set-point, adjustable, shall be 0.05 inches w.g. (adjustable).
5. Temperature Control Contractor is to minimize the length of interior static pressure tubing to improve the system measuring stability.
6. Static pressure sensors manufactured by Building Automation Products, Inc. are preferred. Mamac static pressure sensors are not to be used.

**E. DISCHARGE AIR CONTROL:**

1. The return air and outside air dampers, independently controlled, and heating hot water coil modulating control valve, and the DX cooling controls shall modulate in sequence to maintain the discharge air temperature at set point. The discharge air temperature shall be maintained between 55°F to 95°F (adjustable) based upon the room with the highest cooling percentage strategy. The supply fan shall modulate between the scheduled heating and cooling airflow rates, established in conjunction with the Test and Balance contractor, based upon the room with the highest cooling percentage strategy. The exhaust damper shall control independently of the return and outside air dampers.
2. When the zone temperature is between the occupied heating and cooling set-points (inside of the bias), the supply fan shall modulate to 70% (adjustable) of the cooling/heating airflow rate.
  - a. On a rise in zone temperature, the DAT shall modulate and once it reaches 55 F (adjustable) the supply fan speed shall modulate up to the scheduled cooling airflow rate as required to meet the zone temperature setpoint.
  - b. On a drop in zone temperature, the DAT shall modulate and once it reaches 95 F (adjustable) the supply fan speed shall modulate up to the scheduled heating airflow rate as required to meet the zone temperature setpoint.
  - c. The supply fan shall modulate between 70% (adjustable) of the cooling/heating airflow rate and 100% heating and cooling airflow rates, established in conjunction with the Test and Balance contractor, based upon the room with the highest cooling percentage strategy.
  - d. When CO2 control is implemented as defined later in this section, the supply fan shall modulate to the cooling airflow rate until CO2 levels drop and the primary outside air control takes control.

F. DX COOLING CONTROL (Mechanical Cooling)

1. The packaged DX cooling shall be disabled when the outside air temperature is below 53°F (adjustable).
2. The cooling system shall be controlled based upon the discharge air temperature setpoint. Modulate compressors and expansion valves as required to maintain the discharge air temperature.
3. The packaged DX cooling shall operate based on the unit's packaged controls to maintain the BMS established discharge air temperature set-point.
4. The AHU economizer function shall be disabled when mechanical cooling is provided.
5. The compressors are to be sequenced and operated in a Cascade sequence, and with equal run-time, all established by the Temperature Control Contractor.
  - a. Safeties:
    - 1) Compressor Minimum Off Time: two (2) minutes.
    - 2) Compressor Minimum On Time: three (3) minutes.

G. ECONOMIZER DRY BULB SWITCHOVER:

1. When the outside air temperature is below the return air temperature from the building, the economizer shall be enabled. When the outside air temperature

rises above the return air temperature from the building, the economizer shall be disabled.

2. The economizer function shall be disabled when mechanical cooling is provided.

#### H. HEAT CONTROL:

1. The preheat valve shall modulate to maintain the discharge air temperature at set point (adjustable).
2. Refer to Night Setback/Setup paragraph later in this section.

#### I. OUTDOOR AIR CONTROLS:

1. Primary Control: The outside air damper shall modulate, based on a continuous BMS mixed air temperature calculation, as required to maintain the minimum outside air volume rate as scheduled on the Drawings.
  - a. Mixed Air Temperature Calculation: 
$$\frac{[(\text{scheduled outside air rate} \times \text{outside air temperature}) + (\text{supply air volume rate} - \text{scheduled outside air rate}) \times (\text{return air temperature})]}{\text{supply air volume rate}}$$
    - 1) Note: when the outside air temperature is within 7% of the return air temperature the outside air damper's position is to be placed in a fixed position based on the damper's position immediately before the outdoor air temperature encroachment to the return air temperature. Otherwise the mixed air temperature calculation shall be used unless economizer cooling is provided.
  - b. Refer to the air handling units schedule on the mechanical drawings for each respective air handlers' minimum outside air rate.
  - c. The supply air volume rate shall be established with the Test & Balance contractor. The supply air flowrate shall be a function of the fan speed between the minimum and maximum supply air flowrate.
  - d. The outside air damper position shall compensate for modulating supply air system volumes between minimum and maximum operating points.
    - 1) The temperature control contractor shall establish the positions with the Test & Balance contractor during the balancing phases through the use of a mixed air calculation to establish the minimum outside air setting between maximum and minimum supply air volume flow rates.
    - 2) The temperature control contractor shall report the settings to the engineer and shall display the settings on the project's BMS respective air handling unit graphics.
2. Secondary Control: Provide the capability to modulate the outside air damper for the air handling unit based upon a CO2 sensor located in the return air ductwork serving the air handling unit. The outdoor air damper shall be operated based upon carbon dioxide sensor readings. The sensor set-point shall be 1,000 ppm. If the CO2 value rises above the set-point, the outside air damper shall gradually open from the minimum set-point position to maintain the space CO2 set-point. The outside air flowrate shall not exceed the mixed air low and high temperature limits noted in the Safeties section below. Refer to the Ventilation Summary Schedule on M0.1 for minimum and maximum outside air ventilation rates.
3. The outdoor air damper shall be closed in unoccupied times, in warm up periods and cool down periods, unless outdoor air is required per the cooling sequence of operations to cool down or maintain the setback temperature.

4. Temperature sensors manufactured by Building Automation Products, Inc. are preferred. Mamac temperature sensors are not to be used.

J. FILTER STATUS

1. A Differential Pressure Switch shall be installed across the filter bank to monitor differential pressure across the filters and shall alarm the DDC system when filters are dirty.

K. SAFETIES:

1. All of the safety devices are manual reset; the device that has tripped must be manually reset before restarting the air handling unit, unless otherwise noted below.
2. If a low limit temperature sensor senses a temperature below the established low-limit set point (32 F, adjustable) the supply fan and return fan shall be shutdown. The low limit freeze stat shall be located downstream of the supply fan and placed in a position where the capillary sensing tube is located in a full mixed air-stream.
3. On an indication of a smoke detector (installed by the Electrical Contractor) served by this unit, the supply fan and return fan shall stop and the outdoor air damper shall close. Upon detection of no smoke, the air handling unit shall auto restart and shall operate per the sequence of operations.
4. A low static pressure switch located prior to the return fan senses a suction pressure that is greater than set point, the supply fan and return fan shall be shutdown.
5. If a high static pressure switch located after the supply fan senses a discharge pressure that is greater than set point, the supply fan and return fan shall be shutdown.
6. A mixed air temperature low limit safety equal to the scheduled minimum entering air temperature for the respective air handling unit heating hot water coil shall be implemented in the programming. If the mixed air temperature reaches the mixed air temperature low limit safety, the outside air damper shall gradually close until the mixed air temperature is above the mixed air temperature low limit safety.
7. A mixed air temperature high limit safety equal to the scheduled entering dry bulb air temperature for the respective air handling unit DX coil shall be implemented in the programming. If the mixed air temperature reaches the mixed air temperature high limit safety, the outside air damper shall gradually close until the mixed air temperature is below the mixed air temperature high limit safety.

L. SHUTDOWN:

1. When the unit is shutdown by either a stop command or system safety the unit shall be set as follows:

Supply fan shall be off  
Return fan shall be off  
Supply fan VFD shall be commanded to 0%  
Return fan VFD shall be commanded to 0%  
Outside air damper shall close

Return air damper shall open  
Exhaust air damper shall close  
Heating hot water coil modulating control valve shall remain in control  
DX Cooling shall be disabled

M. MORNING WARMUP MODE:

1. A warm-up mode shall be initiated by an optimal start program to ensure the space temperature is brought up to set-point by the occupied time if all the following conditions exist:
2. The outside air temperature is below 45 F.
3. The coldest space temperature is more than 2 F below the occupied setpoint.
4. During the warm-up mode, the supply fan and return fan shall run continuously, the outside air and exhaust dampers shall be closed, DX cooling shall be disabled, and the heating hot water coil controls shall modulate to maintain the maximum discharge air temperature but no greater than 105 F. The warm-up mode shall be terminated when one of the following conditions exists:
5. The occupied time is reached.
6. The coldest space temperature reaches the occupied set-point.
7. The warmest zone is at least 2 F above set-point.

N. REFRIGERANT LEAK DETECTION:

1. Sequence forthcoming.

O. NIGHT SETBACK/NIGHT SETUP:

1. When in the scheduled “unoccupied” mode, the outside air and exhaust dampers shall be closed, and the return air damper shall be opened. The unit shall cycle as necessary to maintain the night setback zone temperature at set point. A timed cycle differential shall prevent the unit from cycling excessively.
2. If the outdoor air temperature is below zero degree (0) Fahrenheit (adjustable), the supply fan shall be enabled and shall run at minimum speed (allowed by the VFD) to allow general circulation of building air.
3. Occupancy override switches (integral to the new space sensors) shall be located in the space at location(s) designated by the school district to temporarily activate the air handling system into an “occupied” sequence. The temporary occupied sequence will operate for a three (3) hour period (adjustable).

P. MONITOR AND DISPLAY:

1. At a minimum, the following shall be monitored and displayed on the system graphics:
  - a. Supply fan status and speed.
  - b. Return fan status and speed.
  - c. Damper positions.
  - d. Hydronic valve positions.
  - e. Supply Air Volume (based on fan speed established with the T&B contractor).
  - f. Outdoor Air, Return Air, Mixed Air, and Discharge Air temperatures.
  - g. Outdoor Air Volume (from the mixed air temperature calculation).
  - h. Differential Pressure across the filter bank.
  - i. Building Area Static Pressure Set-Point and actual value.

- j. Outdoor air damper control status: mixed air temperature or discharge air temperature (economizer mode).
- k. Packaged DX cooling commanded status.
- l. Packaged DX cooling actual operating status as sensed by a current sensor.
- m. Packaged DX cooling operating values and faults as presented by the unit's packaged control system.
- n. Return CO2 levels.
- o. All system set-points.
- 2. Fan law calculation is as follows:
  - a.  $cfm2 = (rpm2/rpm1) \times cfm1$ 
    - 1)  $cfm1$  = maximum scheduled supply air flow rate for the system
    - 2)  $rpm1$  = motor speed of the direct drive fan at maximum scheduled supply air flow rate for the system. This value shall be determined in conjunction with the Test and Balance Contractor.
  - b.  $rpm2$  = motor speed corresponding to the variable speed drive frequency output.

#### 1.11 VAV BOX WITH HOT WATER REHEAT

- A. OCCUPIED MODE: When the zone temperature is between the occupied heating and cooling set-points (inside of the bias), the primary air damper shall be at the minimum CFM and the reheat valve shall be fully closed. On a rise in zone temperature above the cooling set-point, the primary air damper shall increase the CFM and the reheat valve shall remain fully closed. On a drop in zone temperature below the heating set-point, the damper shall be commanded to its heating CFM position, and the reheat valve shall modulate to maintain the zone temperature heating set-point. The discharge air temperature shall be limited to a maximum discharge air temperature of 120 F (adjustable). The control valve shall operate on a PID loop based on zone temperature and setpoint.
- B. UNOCCUPIED (NIGHT SETBACK) MODE: When the air handling unit shuts down, all box controllers are indexed to unoccupied mode. When the zone temperature is between the unoccupied heating and cooling set-points (inside of the bias), the primary air damper shall be at the minimum CFM, and the reheat valve shall be fully closed. On a rise in zone temperature above the unoccupied cooling set-point, the primary air damper shall increase the CFM (if available), and the reheat valve shall remain fully closed. On a drop in zone temperature below the unoccupied heating set-point, the damper shall be commanded to its heating CFM position, and the reheat valve shall modulate to maintain the zone temperature unoccupied heating set-point. The discharge air temperature shall be limited to a maximum discharge air temperature of 120 F (adjustable). The control valve shall operate on a PID loop based on zone temperature and setpoint.
- C. Monitor and Display
  - 1. VAV air flow value
  - 2. VAV air flow set-points (minimum, heating, and cooling).
  - 3. Damper position.
  - 4. Reheat valve position.
  - 5. Inlet air temperature (from the respective RTU's discharge air temperature).

6. Discharge air temperature.
7. Zone Temperature.
8. Zone Temperature Set-point (occupied and unoccupied).

#### 1.12 VAV BOX WITH HOT WATER REHEAT & CABINET UNIT HEATERS

- A. OCCUPIED MODE: When the zone temperature is between the occupied heating and cooling set-points (inside of the bias), the primary air damper shall be at the minimum CFM and the reheat valve shall be fully closed. On a rise in zone temperature above the cooling set-point, the primary air damper shall increase the CFM and the reheat valve shall remain fully closed. On a drop in zone temperature below the heating set-point, the damper shall be commanded to its heating CFM position, and the reheat valve shall modulate to maintain the zone temperature heating set-point. The discharge air temperature shall be limited to a maximum discharge air temperature of 120 F (adjustable). The control valve shall operate on a PID loop based on zone temperature and setpoint.
- B. UNOCCUPIED (NIGHT SETBACK) MODE: When the air handling unit shuts down, all box controllers are indexed to unoccupied mode. When the zone temperature is between the unoccupied heating and cooling set-points (inside of the bias), the primary air damper shall be at the minimum CFM, and the reheat valve shall be fully closed. On a rise in zone temperature above the unoccupied cooling set-point, the primary air damper shall increase the CFM (if available), and the reheat valve shall remain fully closed. On a drop in zone temperature below the unoccupied heating set-point, the damper shall be commanded to its heating CFM position, and the reheat valve shall modulate to maintain the zone temperature unoccupied heating set-point. The discharge air temperature shall be limited to a maximum discharge air temperature of 120 F (adjustable). The control valve shall operate on a PID loop based on zone temperature and setpoint.
- C. CABINET UNIT HEATERS:
  1. Occupied Mode: On a call for heat if the respective VAV box with reheat coil cannot maintain the zone temperature setpoint, the respective cabinet unit heaters shall be activated to provide supplemental heating to the zone and follow the cabinet unit heater sequence of operations in this section. The cabinet unit heaters shall be disabled once the zone heating temperature is satisfied.
  2. Unoccupied Mode: The respective cabinet unit heaters shall be activated to control the unoccupied zone heating temperature and operate per the sequence of operations in this section. The cabinet unit heaters shall be disabled once the zone heating temperature is satisfied.
- D. Monitor and Display
  1. VAV air flow value
  2. VAV air flow set-points (minimum, heating, and cooling).
  3. Damper position.
  4. Reheat valve position.
  5. Inlet air temperature (from the respective RTU's discharge air temperature).
  6. Discharge air temperature.



7. Zone Temperature.
8. Zone Temperature Set-point (occupied and unoccupied).
9. Cabinet unit heater command and status.

#### 1.13 CABINET UNIT HEATERS & UNIT HEATERS

- A. Note (Except UH-3): Independent control relays and current sensors shall be furnished and installed for each cabinet unit heater and unit heater.
- B. Unit Heater UH-3: Independent control relay, current sensor and a 2-way on/off control valve shall be furnished and installed for the unit heater.
- C. Occupied Mode (Except UH-3): Fan shall cycle on based on a call from a space sensor to satisfy the occupied space temperature set-point. Note: no control valve required, coil is running "wild".
- D. Unoccupied Mode (Except UH-3): Fan shall cycle on based on a call from the space sensor to satisfy the unoccupied (night setback) space temperature set-point. Note: no control valve required; coil is running "wild".
- E. Occupied Mode (UH-3): Fan and temperature control valve shall cycle based on a call from a space sensor to satisfy the occupied space temperature set-point.
- F. Unoccupied Mode (UH-3): Fan and temperature control valve shall cycle based on a call from a space sensor to satisfy the occupied space temperature set-point.
- G. Monitor and Display:
  1. Supply fan command and status.
  2. UH-3 Only: Control valve position.
  3. Space temperature set-point.
  4. Space temperature.
  5. All system set-points.
- H. Alarms:
  1. If the supply fan command does not match the status, an alarm shall be sent to the BMS.

#### 1.14 EXHAUST FAN AND LOUVER LV-1 CONTROLS

- A. Note: Independent current sensors and relays shall be furnished and installed as required for each exhaust fan listed below.
- B. Refer to the Exhaust Fan Schedule on M0.7 for additional control notes.
- C. EF-1:
  1. BMS Schedule to operate with Area A rooftop units operating schedule. Alarm if status doesn't match the commanded value.

- 2. Monitor & Display:
  - a. Exhaust Fan Command and Status
- D. EF-2 THROUGH EF-5: Exhaust fan shall be controlled by the manual switch integral to the respective science fume hood. No BMS integration required.
- E. EF-6, 7, 9, 10, 27:
  - 1. Exhaust fan shall be served by the facility backup power. Temperature control contractor shall provide and install a line voltage reverse acting thermostat to serve the respective exhaust fan. If the space temperature rises above the space temperature setpoint 75 F (adjustable), the exhaust fan shall run. When the space temperature drops below the space temperature setpoint, the exhaust fan shall be off.
  - 2. Temperature control contractor shall provide a space temperature sensor in the respective IT room and shall monitor and display the room temperature. If the respective room temperature rises above 90 F (adjustable), an alarm shall be sent to the BMS.
- F. EF-8, 22, 26, 28, 30, 31, 32, 33, 34, 35:
  - 1. If the space temperature in the electrical room rises above the space temperature setpoint 75 F (adjustable), the exhaust fan shall be enabled and run continuous until the space temperature drops below the space temperature setpoint. Alarm if status doesn't match the commanded value. If the respective room temperature rises above 90 F (adjustable), an alarm shall be sent to the BMS.
  - 2. Monitor and Display:
    - a. Exhaust Fan Command and Status.
    - b. Zone Temperature.
    - c. Zone Temperature Set-point (occupied and unoccupied).
- G. EF-11:
  - 1. BMS Schedule to operate with Area B rooftop units operating schedule. Alarm if status doesn't match the commanded value.
  - 2. Monitor & Display:
    - a. Exhaust Fan Command and Status
- H. EF-12:
  - 1. BMS Schedule to operate with Area C rooftop units operating schedule. Alarm if status doesn't match the commanded value.
  - 2. Monitor & Display:
    - a. Exhaust Fan Command and Status
- I. EF-13, 15:
  - 1. BMS Schedule to operate with RTU-9 operating schedule. Alarm if status doesn't match the commanded value.
  - 2. Monitor & Display:

a. Exhaust Fan Command and Status

- J. EF-14: Exhaust fan shall be controlled by the warewasher controls. No BMS integration required.
- K. EF-16 THROUGH EF-19:
1. The makeup air unit and the respective Type I exhaust fans shall be activated by the remote mounted hood control panel.
  2. Demand Controlled Ventilation:
    - a. The makeup air unit and the respective Type I exhaust fans shall auto activate based on a +10 F differential between the exhaust duct temperature and the room temperature. The makeup air unit supply fan and the respective Type I exhaust fan speeds shall modulate based on duct temperature.
  3. Temperature control contractor is responsible for all low voltage wiring. Electrical contractor is responsible for all line voltage wiring, coordinate with the electrical contractor.
  4. No BMS integration required.
- L. EF-20, 25, 29:
1. BMS Schedule to operate with RTU-8 operating schedule. Alarm if status doesn't match the commanded value.
  2. Monitor & Display:
    - a. Exhaust Fan Command and Status
- M. EF-21, 23, 24:
1. BMS Schedule to operate with RTU-6 operating schedule. Alarm if status doesn't match the commanded value.
  2. Monitor & Display:
    - a. Exhaust Fan Command and Status
- N. EF-22 & LV-1 (Main Mechanical Room):
1. Exhaust fan EF-22 is provided with a ECM motor with 0-10 VDC input control.
  2. A 24-volt motorized damper with position end switches shall provided and install in the outside air ductwork serving LV-1 by the mechanical contractor.
  3. When the outside air temperature is greater than the space temperature, the exhaust fan shall remain off and the motorized damper serving the louver shall be closed independent of the space temperature and space temperature setpoint.
  4. When the space temperature is below the space temperature setpoint of 75 F (adjustable), the exhaust fan shall remain off and the motorized damper serving the louver shall be closed.
  5. When the space temperature rises above the space temperature setpoint of 75 F (adjustable) and the outside air temperature is less than the space temperature, the louver motorized damper shall open and the exhaust fan shall be enabled and slowly modulate to maintain the space temperature setpoint. Provide a time delay to allow for the louver motorized damper to open prior to enabling the exhaust fan.

6. If the exhaust fan or louver motorized damper status does not match the commanded value, an alarm shall be sent to the BMS.
  7. Monitor and display the exhaust fan and louver motorized damper command and status, outside air temperature, space temperature setpoint, the space temperature and all system set-points.
- O. EF-36 & EF-37: Exhaust fan shall run continuous 24/7. Temperature control contractor shall provide a current sensor and interface the exhaust fan status with the building management system. An alarm shall be generated on the BMS if the exhaust fan current sensor does not sense the fan enabled.
- P. EF-KL1 & EF-KL2: Exhaust fan shall be controlled by the respective kiln controls. No BMS integration required.

#### 1.15 DIRECT FIRED, MAKEUP AIR UNIT MUA-1:

- A. Makeup air unit is furnished with a packaged controller for remote mounting and a room air temperature sensor. Temperature control contractor is to field install these devices and wire following the makeup air unit's installation guidelines.
- B. Refer to the exhaust fan sequence of operation for integration between exhaust fans and associated makeup air unit.
- C. Upon activation of the Type I hood exhaust fan(s), via the hood controls or the hood's integral heat sensors, the outside air damper shall open 100%, and the makeup air fan shall energize and run continuously.
- D. Upon deactivation of the Type I hood exhaust fans, the makeup air fan shall de-energize, and the outside air damper shall close.
- E. Discharge Air Temperature Control:
  1. Heating: The makeup air unit will supply 100% outside air and will modulate the gas burner to maintain a 70 F (adjustable at the remote control panel) discharge air temperature during the operation of the makeup air unit.
  2. Cooling:
    - a. Fan enabled.
    - b. Evaporative Cooling Enable Set Point: 75°F (adjustable).
    - c. Outdoor air below cooling enable set-point:
      - 1) Burner and Evaporative Cooling disabled.
    - d. Outdoor air above cooling enable set-point:
      - 1) Burner disabled.
      - 2) Evaporative Cooling enabled and the solenoid valve for the cold water supply will cycle on/off as set by the factory settings to saturate the evaporative cooling unit media to deliver conditioned air.
      - 3) Excess and collected water in the evaporative cooler will gravity drain to the facility's sanitary drainage system.
      - 4) A freeze protection, solenoid valve(s) (shipped loose with the unit and field installed) will disable the water supply and drain when the outdoor air temperature is sensed below freezing.

- F. Demand Controlled Ventilation:
  - 1. The makeup air unit and the respective Type I exhaust fans shall auto activate based on a +10 F differential between the exhaust duct temperature and the room temperature. The makeup air unit supply fan and the respective Type I exhaust fan speeds shall modulate based on duct temperature.
  - 2. Temperature control contractor shall field install the associated wiring from the DCV to the exhaust temperature sensor on the Type I hoods. Coordinate installation with the electrical contractor.
- G. No BMS monitor and display requirements for the Type I hood exhaust fans or makeup air unit:

#### 1.16 SPLIT SYSTEM COOLING UNITS CRU-1/CU-1 THROUGH CRU-6/CU-6

- A. The split system cooling unit system is equipped with a BMS communication link, coordinate protocol with the equipment manufacturer. Temperature control contractor shall provide a BACnet communication converter as required. The BMS shall display the split system cooling units operating values, faults and alarms as presented by the split system cooling units packaged control system. The system shall operate using its packaged control components.
- B. Temperature control contractor shall provide a temperature sensor in the IT room to monitor and display the IT room temperature. Send an alarm to the BMS if the IT room temperature rises above 85 F (adjustable).
- C. Monitor and Display
  - 1. Room Temperature.
  - 2. System Operating Values, Faults & Alarms.

#### 1.17 WALL MOUNTED RANGE HOOD RH-1

- A. Range hood shall operate on the control provided with the hood. No BMS integration required.

#### 1.18 DOMESTIC HOT WATER SYSTEM

- A. Note: Independent control relays and current sensors shall be furnished and installed to serve the domestic hot water recirculation pump.
- B. Domestic hot water system shall have dedicated graphics independent of an other plants or equipment in the facility.
- C. The domestic hot water recirculation pump is to be scheduled to operate 24-hours/day, 7-days / week.
- D. The BMS shall monitor and display the domestic hot water temperature downstream of the domestic hot water heaters and the domestic hot water recirculation temperature from the building. Temperature data shall be stored in a history file. When the domestic

hot water temperature is beyond the normal temperature operating parameters, 120°F low limit (adjustable) and 150°F high limit (adjustable) for more than 5 minutes (adjustable), an alarm shall be sent to the BMS.

E. Monitor and Display:

1. Domestic hot water recirculation pump status.
2. Water temperatures described above.
3. All system set-points.

1.19 ELEVATOR SUMP PUMP P-1

- A. Monitor and display sump pump P-1 alarms on the BMS via the sump pump control panel dry set of alarm contacts. If the sump pump alarm is activated, an alarm shall be sent to the BMS.

END OF SECTION 230993

## SECTION 231123 - FACILITY NATURAL-GAS PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Dielectric unions.
7. Sleeves.
8. Mechanical sleeve seals.

#### 1.2 PERFORMANCE REQUIREMENTS

##### A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.

##### B. Natural-Gas System Pressures within Buildings: 2.0 psig or less.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Welding certificates.
- C. Field quality-control reports.
- D. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

- C. 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.

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

### 2.2 PIPING SPECIALTIES

- A. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

### 2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

### 2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig.
  - 2. Threaded Ends: Comply with ASME B1.20.1.
  - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.



5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. BrassCraft Manufacturing Company; a Masco company.
  - b. Conbraco Industries, Inc.; Apollo Div.
  - c. Lyall, R. W. & Company, Inc.
  - d. McDonald, A. Y. Mfg. Co.
  - e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Lee Brass Company.
  - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Eccentric Plug Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. SMG Valves

2. Description: Key Port Series 400
3. Body: Cast Iron.
4. Plug: Bronze or cast iron.
5. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig.
8. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Lubricated Cast Iron Plug Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Homestead

2. Description: Series 600
3. Valve design shall conform to MSS-SP-78, Type IV, Class 125
4. Valves shall conform to ASME/ANSI B16.33 (1/2" through 2") and ASME/ANSI B16.38 (2-1/2" through 12").
5. Body: Cast Iron.
6. Plug: Gray Iron casting.
7. Ends: End flanges shall be integral with the valve body. Flange drilling and
8. thickness shall conform to ASME/ANSI B16.1 for pressure Class 125.
9. End flanges shall be integral with the valve body. Flange drilling and
10. thickness shall conform to ASME/ANSI B16.1 for pressure Class 125 Pressure.
11. Flange faces shall be finished in accordance with MSS SP-6.
12. Valves shall be furnished with a lubricating/sealing system to provide a means for delivering plug valve lubricant/sealant to the body-plug interface.
13. Class: 125 psig.
14. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction suitable for natural-gas service.

## 2.5 WALL ACCESS PANELS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acudor

2. Material: Up to 16" X 16" – 16 gauge, 18 gauge mounting frame, over 16" X 16" - 14 gauge door, 16 gauge mounting frame.
3. Fire Rating: Fire rated for installations in fire rated assemblies.
4. Door: Flush to frame with rounded safety corners.
5. Mounting frame: One piece outer flange welded to mounting frame.
6. Hinge: Continuous, concealed.
7. Latch: Stainless Steel screwdriver operated cam latch.

8. Locks: Cylinder lock and key. Provide spare set of keys for each access panel.
9. Finish: Stainless Steel: Type 304 - #4 satin polish.
10. Size: Field coordinate for piping system served.

## 2.6 PRESSURE REGULATORS

### A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 4 and smaller.

### B. Lock-up Style Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Meter Company.
  - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
  - c. Invensys.
  - d. Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: Refer to Drawings.
13. Outlet Pressure: Refer to Drawings.

## 2.7 PIPING SPECIALTIES

### A. Flexible Connector:

1. Flexible connector to be capable of compensating for lateral movement and vibration.
2. Flexible connector to be manufactured complete with section of corrugated metal hose, compatible braid, with threaded inlet and outlet connections.
3. For flammable gas service up to 4"; CSA / AGA Certified.

4. Corrugated Hose: 304 Stainless Steel.
5. Braid: 304 Stainless Steel
6. Operating-Pressure Rating: 1.0 psig.
7. End Fittings: Zinc-coated steel.
8. Threaded Ends: Comply with ASME B1.20.1.
9. Maximum length: 36-inches.

## 2.8 DIELECTRIC UNIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Capitol Manufacturing Company.
  2. Central Plastics Company.
  3. Hart Industries International, Inc.
  4. McDonald, A. Y. Mfg. Co.
  5. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
  6. Wilkins; Zurn Plumbing Products Group.
- B. Minimum Operating-Pressure Rating: 150 psig.
- C. Combination fitting of copper alloy and ferrous materials.
- D. Insulating materials suitable for natural gas.
- E. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

## 2.9 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

## 2.10 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

## PART 3 - EXECUTION

### 3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. All outdoor, exposed piping shall be primed and painted by the plumbing contractor. Color to match building color. Coordinate with the Architect.
- C. Install fittings for changes in direction and branch connections.
- D. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- F. Install flexible connector at connection to the facility backup generator.

### 3.2 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- L. Verify final equipment locations for roughing-in.
- M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install relief vent piping for regulators at the natural gas service as required to meet all applicable clearance requirements and as directed by the local utility company.

- V. Install new pressure regulator to serve the building natural gas service as indicated on the Drawings. Provide transitions and offsets as required. Install new pressure regulator per the pressure regulator manufacturer's installation guidelines and per the local utility company guidelines. Coordinate installation with the local utility company. Paint new and existing natural gas piping exterior to the building, coordinate color with the Owner.
- W. Provide wall access panels to serve natural gas valves and accessories serving science classrooms as noted on the drawings.

### 3.3 VALVE INSTALLATION

- A. Install manual gas shutoff valve downstream of the natural gas meter before the natural gas service piping enters the building.
- B. Install manual gas shutoff valve for each gas appliance.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

### 3.4 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  - 2. Cut threads full and clean using sharp dies.
  - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
  - 5. 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.
- D. Welded Joints:
  - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
  - 2. Bevel plain ends of steel pipe.
  - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Swivel ban or adjustable steel hangers for individual horizontal piping 1-1/2 NPS or less.
  - 3. Adjustable steel clevis hangers for individual horizontal piping 2 NPS or greater.
- C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
  - 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

### 3.6 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### 3.7 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

### 3.8 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.



### 3.9 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.

### 3.10 INDOOR PIPING SCHEDULE

- A. Aboveground, natural gas piping shall be the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.

### 3.11 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 8 and smaller at service meter shall be one of the following:
  - 1. Eccentric plug valve.
  - 2. Lubricated cast iron plug valve.
- B. Distribution piping valves for pipe sizes NPS 8 and smaller shall be one of the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
  - 3. Eccentric plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
  - 3. Eccentric plug valve.

END OF SECTION 231123

## SECTION 232113 - HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Hot-water heating piping.
  - 2. Condensate-drain piping.
  - 3. Balance and drain valves.
  - 4. Air-vent piping.
  - 5. Safety-valve-inlet and -outlet piping.
- B. No welded hydronic piping will be permitted for this project.
- C. See Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
- D. See Division 23 Section "Water Treatment" for Chemical Treatment System.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
  - 1. Hot-Water Heating Piping: 150 psig at 200 deg F.
  - 2. Condensate-Drain Piping: 150 deg F.
  - 3. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Wrought-Copper Fittings: ASME B16.22.
  - 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. Anvil International, Inc.
    - b. S. P. Fittings; a division of Star Pipe Products.
    - c. Victaulic Company of America.
  - 2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
  - 3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Copper Pressure-Seal-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Viega; Plumbing and Heating Systems.
    - b. Nibco.
  - 2. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

### 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- G. Grooved Mechanical-Joint Fittings and Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
    - c. National Fittings, Inc.
    - d. S. P. Fittings; a division of Star Pipe Products.
    - e. Victaulic Company of America.
  - 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
  - 3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. Couplings shall accommodate pipe thermal expansion and contraction and shall be a Victaulic Style 177 flexible coupling or approved equal.
  - 4. Victaulic Model #'s 741 and 743 flange kits shall not be used in the project.

## 2.3 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedule 40.
  - 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe.
- B. PVC Plastic Pipe: ASTM D 1785, Schedule 40.
  - 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe.

## 2.4 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 maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.
- F. Solvent Cements for CPVC Piping: ASTM F 493.
- G. Solvent Cements for PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

## 2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - b. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
  - 2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

## 2.6 VALVES

- A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flow Design Inc.
  - b. Griswold Controls.
  - c. Nexus.
  - d. Pro Hydronic Specialties.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

2.7 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol
2. Bell & Gossett Domestic Pump; a division of ITT Industries.
3. Grundfos.
4. Taco.
5. The John Wood Company.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Expansion Tanks:

1. Seamless bladder type for permanent separation of air and water.
2. Water shall expand into the bladder. Air precharge shall be on the shell side.
3. Shell shall be fabricated steel designed and constructed per ASME Section VII, Division 1.
4. Bladder shall be heavy duty butyl removable for inspection.
5. Working Pressure: 125 psig.

6. Operating temperature – 240 F max.
7. Provide with lifting rings.
8. See mechanical schedule for additional requirements.

## 2.8 IN-LINE AIR SEPARATORS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Spirotherm: Spirovent dirt microbubble eliminator and dirt separator.
  2. Taco.
- B. Maximum Working Pressure: Up to 150 psig.
- C. Maximum Operating Temperature: Up to 270 deg F.
- D. See mechanical drawings for additional requirements.

## 2.9 HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers:
  1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  4. CWP Rating: 125 psig.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Welded hydronic piping will not be permitted for this project.
- B. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
  1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure seal joints.
  2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- C. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- D. Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure seal joints.
- E. Condensate Drain Piping shall be the following:
  1. Cooling coil condensate drain piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints unless otherwise noted on the drawings.
- F. Boiler Flue Vent Condensate Drain Piping: Refer to Drawings for requirements.
- G. Air-Vent Piping:
  1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
  2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

### 3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install autoflow balancing valves where shown on the drawings.
- C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

### 3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping in the general areas as shown on the drawings. If significant deviations are required contact the Engineer.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- 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 above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on inlet side of each boiler and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blow-down connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.
- T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- U. Do not install piping directly above electrical, IT or temperature control panels or equipment.

### 3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Swivel band or adjustable steel hangers for individual horizontal piping 1 1/2 inch or less.
  - 2. Adjustable steel clevis hangers for individual horizontal piping 2 inch and greater in size.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
  - 7. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
  - 8. NPS 3-1/2: Maximum span, 13 feet; minimum rod size, 1/2 inch.
  - 9. NPS 4 to 6: Maximum span, 14 feet; minimum rod size, 5/8 inch.
  - 10. NPS 8 to 10: Maximum span, 14 feet; minimum rod size, 3/4 inch.
- D. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
  - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.
  - 7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- F. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 5. NPS 6: 48 inches with 3/4-inch rod.
  - 6. NPS 8: 48 inches with 7/8-inch rod.

- G. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

### 3.5 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 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. 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 complying with ASTM B 32.
- E. 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.
- 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 coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- H. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- I. 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, 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.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.

### 3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- C. Install drain valve on air separators NPS 2 and larger.

### 3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.

### 3.8 CHEMICAL TREATMENT

- A. Refer to Division 23 "Water Treatment" for chemical treatment requirements.
- B. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
  - 1. Hot-Water Heating Piping: 35% percent propylene glycol.

### 3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, un-insulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
  - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" values in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

## SECTION 232123 - HYDRONIC PUMPS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Close-coupled, in-line hydronic centrifugal pumps.
  - 2. Separately coupled, base-mounted, end-suction centrifugal pumps.
  - 3. Pump specialty fittings.

#### 1.2 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include product data specifications on the mechanical seals.
- B. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

#### 2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Grundfos
  - 2. Taco, Inc.

- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
  - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
  - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  - 4. Mechanical Seal: Mechanical Seal: Seals shall be compatible with a propylene glycol solution. Contractor shall take a water sample of existing heating hot water fluid and transmit to the pump manufacture for their review to apply correct mechanical seal application. Furnish one (1) spare seal element with gaskets for replacement for each different size of pump furnished.
  - 5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  - 6. Pump Bearings: Permanently lubricated ball bearings.
- D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for Equipment."
- E. Capacities and Characteristics:
  - 1. Refer to the drawings for pump performance capacities and characteristics.

## 2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
  - 1. Grundfos.
  - 2. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
  - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  4. Mechanical Seal: Seals shall be compatible with a propylene glycol solution. Seal type shall be as recommended by the pump manufacture for the type and concentration of propylene glycol solution. Furnish one (1) spare seal element with gaskets for replacement for each different size of pump furnished.
  5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor and EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Variable speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment." Provide shaft grounding rings on pump motors controlled with variable frequency drives.
- H. Capacities and Characteristics:
1. Refer to the drawings for pump performance capacities and characteristics.

## 2.4 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
- B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.
- C. Pump Flexible Connectors: See details on the mechanical drawings for requirements. Acceptable Manufacturers: Engineered Flexible Products, Mason Industries, Metraflex.



## PART 3 - EXECUTION

### 3.1 PUMP INSTALLATION

- A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. Set base-mounted pumps on existing concrete inertia bases. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
  - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
  - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

### 3.2 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install flexible connectors as described and listed on the drawings on the suction and discharge sides of base-mounted pumps between pump casing and valves.
- E. Install triple-duty valve on discharge side of pumps.

- F. Install suction diffuser and shutoff valve on suction side of pumps.
- G. Install pressure gages on pump as shown on the mechanical details in the project drawings.

### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping. Use startup strainer for initial startup.
  - 4. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in correct direction.
    - d. Complete pump alignment in accordance with manufacturer's instructions.
  - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 6. Start motor.
  - 7. Open discharge valve slowly.
- B. Prepare startup, test, and inspection reports and submit to the Project's Engineer and include reports in the project's pump Operation and Maintenance Manual.

### 3.5 SPARE PARTS

- A. Furnish one (1) spare mechanical seal element with gaskets for replacement for each different size of pump furnished.

END OF SECTION 232123

## SECTION 232300 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-454B or R-32:

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
  - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

#### 1.5 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L or ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
  - 4. Pressure Rating: Factory test at minimum 500 psig.
  - 5. Maximum Operating Temperature: 250 deg F.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Liquid Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

### 3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install flexible connectors at connection to the Condensing Unit.
- B. Provide additional valves, fittings and accessories as required for installation per the split system cooling unit manufacturer installation guidelines.

### 3.3 PIPING INSTALLATION

- A. 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 Shop Drawings.

- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" for controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
  - 1. Install horizontal suction lines with a uniform slope downward to compressor.
  - 2. Install traps to entrain oil in vertical runs.
  - 3. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- Q. Seal penetrations through fire and smoke.

- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- T. Seal pipe penetrations through exterior walls.
- U. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

### 3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual.
  - 2. Spring hangers to support vertical runs.
  - 3. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
  - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

### 3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
  - 4. Charge system with a new filter-dryer core in charging line.

### 3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Open shutoff valves in condenser water circuit.
  - 2. Verify that compressor oil level is correct.
  - 3. Open compressor suction and discharge valves.
  - 4. Open refrigerant valves except bypass valves that are used for other purposes.
  - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

END OF SECTION 232300



## SECTION 232500 - HVAC WATER TREATMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Chemical treatment and equipment
2. HVAC water-treatment chemicals.

#### 1.2 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating, shall have the following water qualities:

1. pH: Maintain a value within 7 to 11.
2. Dissolved Solids < 2,000 ppm.
3. Iron < 0.3 ppm.
4. Chlorides < 150 ppm.
5. Total Hardness < 9 gpg.
6. Include a biocide to limit the growth of bacteria.
7. Corrosion inhibiting compounds shall be provided to protect metals used in the system. Corrosion inhibitor shall be comparable to Sentinel X100 or Fernox F1.
8. Strong Acids shall not be used.
9. Chemical additives must be approved for use in the boilers.
10. Heating Hot Water System: 35% Propylene Glycol.

#### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate source water quality available at Project site.

#### 1.4 QUALITY ASSURANCE

- A. Water treatment contractor shall be Apex Mechanical. Contact Justin Strong 307-949-0263.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

### PART 2 - PRODUCTS

#### 2.1 CHEMICAL TREATMENT EQUIPMENT AND GLYCOL

- A. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- B. Propylene Glycol: Industrial grade with additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

#### 2.2 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

#### 2.3 HEATING HOT WATER AUTOMATIC GLYCOL-FEED EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Axiom
- B. Refer to the mechanical Drawings equipment schedule for schedule of automatic glycol feeder.

#### 2.4 SINGLE BAG SOCK FILTER

- A. Single Bag Sock Filter: Filter Specialties, Inc.
  1. Model: Filtra Systems Model FSC2010200S4NR-B
  2. Design Pressure: 150 psi at 149 F.
  3. Construction Material: 304 Stainless Steel.

4. Basket Material: 304 Stainless Steel.
5. Gasket Material: BUNA N
6. Lifting Mechanism: Band clamp
7. Filters: furnish fifty one (51).
8. Accessories: As scheduled on the Mechanical Drawings.

## PART 3 - EXECUTION

### 3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

### 3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install sock filter equipment per the manufacturer's installation guidelines. Reference the mechanical drawings for further details and instructions.
- C. Install automatic glycol feeder per the manufacturer's installation guidelines. Reference the mechanical drawings for further details and instructions.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for Plumbing and HVAC Piping."

### 3.4 CHEMICAL TREATMENT

- A. All heating hot water equipment, terminal units, piping, and strainers shall be cleaned prior to final water treatment.
- B. Prior to fill and startup, flush the entire heating system.

- C. Clean the entire heating system with a pre-commissioning cleaner comparable to Sentinel X300 or X400 and Fernox F3 or DS40 in accordance with the manufacturer's recommendations. Take samples of the system water with cleaner and analyze to ensure proper cleaner strength. Provide water analysis report with recommended and actual cleaner strength in the project O&M manuals for the boiler and building loops. Under no circumstance shall petroleum based cleaning compounds be used in the boiler system.
- D. Flush the cleaning solution out of the entire system and refill.
- E. Add initial chemical treatment and maintain water quality in ranges noted in Part 1 "Performance Requirements" Article for the first year of operation.
- F. System capacities listed on the Mechanical Drawings are approximate. It is the contractor's responsibility to determine the actual system capacity.
- G. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
  - 1. Heating Hot Water Piping: 35 percent propylene glycol.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  - 3. Place chemical pot feeder and automatic glycol feeder into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
  - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. At 4-weeks, 6-months, and 11-months following Substantial Completion, perform separate water analyses on each hydronic systems to show that chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis to the Owner and Engineer describing any water treatment changes that were made to adhere to the requirements in Part 1 "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
  2. Acidity and Alkalinity: ASTM D 1067.
  3. Iron: ASTM D 1068.
  4. Water Hardness: ASTM D 1126.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232500

## SECTION 233113 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Prefabricated Double Wall Listed Grease Ducts.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

##### B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.4 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

## PART 2 - PRODUCTS

### 2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.2 ROUND AND OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Lindab Inc.
  - b. Omni Duct
  - c. L&L Fabrication
  - d. McGill AirFlow LLC.
  - e. SEMCO Incorporated.
  - f. Sheet Metal Connectors, Inc.
  - g. Spiral Manufacturing Co., Inc.
  - h. Other qualified fabricator subject to compliance with requirements.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 PREFABRICATED DOUBLE WALL LISTED GREASE DUCTS

- A. Description: Factory-fabricated, -listed, and -labeled, double-wall ducts. Furnish double wall, factory built grease duct for use with Type I kitchen hoods, which conforms to the requirements of NFPA-96. Products shall be ETL listed to UL-1978 and UL-2221 for venting air and grease vapors from commercial cooking operation. Install per National Fire Protection Association "NFPA 96"; Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations. Double wall grease ducts shall be listed for a continuous internal temperature of 500 degrees F and intermittent temperatures of 2000 degrees F.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Captive Aire.
  - b. Schebler.
- C. Construction: The duct sections shall be constructed of an inner duct wall and an outer wall with insulation in between. The inner duct wall shall be constructed of .036 inch thick, 430 type stainless steel. The outer wall shall be constructed of stainless steel at a minimum of .024 inch thickness. The duct, based on model number, shall include layers of Super Wool 607 Plus or Insulfrax Elite Blanket insulation between the inner and outer wall. Grease duct joints shall be held together by means of formed V clamps and sealed with 3M Fire Barrier 2000+. The duct wall assembly shall be tested and listed at  $\frac{3}{4}$ " or zero inch clearance, according to classifications. Ductwork shall be classified under UL2221 (Test of Fire Resistive Duct Enclosure Assemblies) as an



alternate to 2-Hr. fire resistive shaft enclosures with a reduced clearance to combustibles.

## 2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- F. Polyvinyl Coated Ductwork: prime, hot-dipped, G-90 galvanized steel cleaned and fire-treated. Special epoxy primer bonded to both sides of the metal. 4-mil polyvinyl coating heat-fused to both sides.

## 2.5 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  - 2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

- b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
- 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
- 4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
  - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
  - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
  - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  - 3. Butt transverse joints without gaps, and coat joint with adhesive.
  - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  - 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
  - 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
  - 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    - a. Fan discharges.
    - b. Intervals of lined duct preceding unlined duct.
    - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
  - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
  1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  8. Service: Indoor or outdoor.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
  1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.
  3. Grade: NS.
  4. Class: 25.
  5. Use: O.
  6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
  1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
  2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for All Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports:
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. All ducts above corridor areas to be minimum 24 gauge sheet metal. All ductwork above classrooms or occupied spaces to be minimum 22 gauge sheet metal.
- D. Install round and oval ducts in maximum practical lengths.
  1. Install spiral round duct upstream of all VAV boxes or terminal units.
  2. Install spiral round ductwork where round ductwork is exposed.
  3. Install spiral round ductwork where round ductwork is exterior of the building. Install with seam joints facing down to shed water.

4. Install spiral round ductwork for all science fume hood exhaust systems. All duct and fittings shall be polyvinyl coated ductwork.
  5. Install spiral round ductwork for all art room spray booth exhaust systems.
  6. Install spiral round ductwork for all art kiln exhaust systems.
  7. Install longitudinal seam round duct or spiral round duct downstream of all VAV boxes or terminal units.
- E. All warewasher exhaust ductwork shall be aluminum or stainless steel with welded or soldered seams water tight. Utilize radius elbows.
  - F. All exposed ductwork in finished areas shall have a paint-lok finish and shall be left clean for field painting by others.
  - G. Install ducts with fewest possible joints.
  - H. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
  - I. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
  - J. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
  - K. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
  - L. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
  - M. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
  - N. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
  - O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

- D. Repair or replace damaged sections and finished work that does not comply with these requirements.
- E. All exposed round duct in finished spaces shall be spiral seamed. Duct finish for exposed duct in finished spaces shall be "paint-lok" galvanized or mil phosphatized.

### 3.3 INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN TYPE I HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install prefabricated double wall listed grease duct per the grease duct manufacture, IMC and NFPA installation guidelines.

### 3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor-Air, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor-Air, Exhaust Ducts: Seal Class C.
  - 4. Outdoor-Air, Return-Air Ducts: Seal Class C.
  - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
  - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Hanger Exposed to View in Finished Spaces: Use steel cable support.
- F. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

### 3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:
  1. Ducts Connected to Terminal Units:

- a. Pressure Class: Positive 1-inch wg.
    - b. Minimum SMACNA Seal Class: C.
  - 2. Ducts Connected to Air-Handling Unit and VAV Terminal Units (upstream connection):
    - a. Pressure Class: Positive 3-inch wg.
    - b. Minimum SMACNA Seal Class: A.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 3-inch wg.
    - b. Minimum SMACNA Seal Class: B.
- C. Return Ducts:
- 1. Ducts Connected to Terminal Units:
    - a. Pressure Class: Positive or negative 1-inch wg.
    - b. Minimum SMACNA Seal Class: C.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
- D. Exhaust Ducts:
- 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 1-inch wg.
    - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:



1. Ducts Connected to Terminal Units:
  - a. Pressure Class: Positive or negative 1-inch wg.
  - b. Minimum SMACNA Seal Class: B.
2. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: B.
3. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: B.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

G. Liner: (where noted on the mechanical Drawings)

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch thick.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch thick.
3. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3,

"Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
  - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Retain first three subparagraphs below, or delete and retain fourth subparagraph.
    - 2) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 3) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 4) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    - 5) Radius-to Diameter Ratio: 1.5.
  - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.
4. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: 45-degree entry.
5. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1500 fpm or lower: Conical tap.
  - b. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

## SECTION 233300 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Duct mounted motorized dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Ceiling radiation dampers.
5. Duct silencers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
  - a. Special fittings.
  - b. Manual volume damper installations.
  - c. Control damper installations.
  - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
  - e. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.2 DUCT MOUNTED MOTORIZED DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation.
  - 2. Nailor Industries Inc.
  - 3. Pottorff; a division of PCI Industries, Inc.
  - 4. Ruskin Company.
- B. Frame: 16 ga. Galvanized steel hat channel with die-formed corner gussets.
- C. Blades: 16 ga. Galvanized steel vee groove design. Opposed action.
- D. Linkage: Concealed type totally enclosed within the frame and out of the airstream. Plated steel.
- E. Bearings: Oilite.
- F. Axles: 1/2" dia. Plated steel double bolted to blades.

- G. Leakage: Less than 10 cfm per sq. ft at 4" w.g. (0.5% at 2000 fpm).
- H. Blade seals: Dual durometer bulb type extruded PVC.
- I. Jamb seals: Compression type cambered metal.
- J. Temperature Range: -50°F to +180°F
- K. Rated pressure and velocity to exceed design airflow conditions.
- L. Damper Motors: two-position action.
- M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." And Division 26 Sections.
  - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf. Actuator shall be external mount.
  - 5. Electrical Connection: 24V, coordinate with the temperature control contractor.
- N. Accessories:
  - 1. Position Indicator, coordinate with the temperature control contractor.
  - 2. Actuator mounting side plate.

## 2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Air Balance Inc.; a division of Mestek, Inc.
    - b. American Warming and Ventilating; a division of Mestek, Inc.
    - c. Cesco Products; a division of Mestek, Inc.
    - d. Greenheck Fan Corporation
    - e. Nailor Industries Inc.
    - f. Pottorff; a division of PCI Industries, Inc.
    - g. Ruskin Company.
  - 2. Frame: 20-gauge galvanized steel unless otherwise noted, see Finish below.

3. Blades: 20-gauge galvanized steel unless otherwise noted, see Finish below.
4. Control Shaft / Hand Quadrant: 3/8" square axle shaft extending beyond frame through factory mounted, locking hand quadrant.
5. Bearing: Molded synthetic.
6. Finish:
  - a. Mill galvanized unless otherwise noted.
  - b. Aluminum for dampers installed in aluminum ductwork.
  - c. Stainless steel for dampers installed in stainless steel ductwork.
  - d. Stainless steel for dampers installed in science fume hood exhaust systems.
7. Insulation Bracket: 2" hand quadrant stand-off bracket.

## 2.4 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Nailor Industries Inc.
  2. Pottorff; a division of PCI Industries, Inc.
  3. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 hours or as identified on the Drawings.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
  2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

## 2.5 CEILING RADIATION DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Nailor Industries Inc.
  - 2. Pottorff; a division of PCI Industries, Inc.
  - 3. Ruskin Company.
- B. Type: Rated and labeled according to UL 555C by an NRTL. UL approved for dual directional air flow.
- C. Frame:
  - 1. Style: one piece roll formed construction.
  - 2. Material: Minimum 24 gage (0.75 mm) galvanized steel.
- D. Blades:
  - 1. Style: Two-piece, single-thickness with blade insulation, hinged in center, and held open with fusible link.
  - 2. Action: Butterfly.
  - 3. Orientation: Horizontal.
  - 4. Material: Minimum 24 gage (0.75 mm) galvanized steel.
- E. Hinge: Spring stainless steel, mechanically attached to blades.
- F. Mounting: Horizontal.
- G. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- H. Finish: Mill galvanized.
- I. Assembly: Factory assemble damper and accessories and furnish as a single unit conforming to UL 555C.

## 2.6 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Price.
  - 2. Vibro-Acoustics, A Swegon Group Company.
  - 3. SEMCO, IAC Acoustics.
- B. Reference Standards
  - 1. ASHRAE Applications Handbook, Chapter 48 "Noise and Vibration Control"; 2015
  - 2. ASHRAE 62.1 – Ventilation For Acceptable Indoor Air Quality; 2013
  - 3. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot dip Process; 2015

4. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials; 2016
5. ASTM E477-13 – Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers; 2013
6. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015
7. NFPA 90B – Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2015
8. NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials; 2006
9. SMACNA 006-2006 – HVAC Duct Construction Standards – Metal and Flexible; 2006
10. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials; 2008

#### C. Submittals

##### 1. Product Data:

- a. Silencer manufacturer to provide submittal drawings detailing all duct silencer data specified in the mechanical drawing schedule.
- b. Silencer manufacturer shall submit certified laboratory performance obtained using ASTM E477-13. The laboratory must be NVLAP accredited for the ASTM E477-13 test standard and a copy of the accreditation certificate must be included with submittals. Data from non-NVLAP accredited test facilities is not acceptable.
- c. Submitted silencer pressure drops should not exceed those listed in the silencer schedule unless approved by project engineer. Silencer pressure drop measurements shall be made in accordance with ASTM E477-13.
- d. Submitted silencer dynamic insertion loss and self-noise data should satisfy values listed in the silencer schedule at the project's air distribution system airflow requirements. ASTM E-477-13 tests to obtain this data shall be conducted in the same facility and utilize the same silencer.
- e. Silencer dynamic insertion loss shall not be less than that listed in the silencer schedule unless approved by the project engineer.
- f. Silencer generated noise shall not be greater than that listed in the silencer schedule unless approved by the project engineer.
- g. The silencer manufacturer shall provide, for approval, acoustic calculations for relevant duct systems with silencers to validate that the submitted silencers will satisfy occupied space design guidelines. Use sound power levels of actual equipment scheduled for installation on project. Acoustic Analysis shall include breakout noise calculations as required. In the absence of specified background noise level criteria, the guidelines outlined in the 2015 ASHRAE Applications Handbook Chapter 48, Table 1 shall apply.
- h. Silencer manufacturer shall provide test data for silencer(s) as indicated in the silencer schedule if requested by the project engineer that complies with project criteria.

#### D. Quality Assurance

1. Silencers shall be installed in accordance with NFPA 90A and with NFPA 90B.



2. Silencer performance must have been substantiated in a duct-to-reverberant room test facility in accordance with ASTM E477-13. The test facility must provide airflow in both directions through the test silencer. The test set-up shall eliminate effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption. The aero-acoustic laboratory must be currently NVLAP accredited for ASTM E477-13. Test facilities and reports shall be open to inspection from project engineer.
3. Silencer manufacturer must have a minimum ten (10) years of industry experience. Duct Silencers-2 v001
4. Silencer manufacturer shall provide a copy of their laboratory NVLAP accreditation certificate for the ASTM E-477-13 test standard with the submittals. Data from non-NVLAP accredited test facilities is not acceptable.

E. General:

1. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. Silencers shall be fabricated by the same manufacturer.
2. Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings or approved by the project engineer.

F. Construction:

1. Silencers shall be constructed in accordance with ASHRAE and SMACNA Standards for the pressure and velocity classification specified for the air distribution system in which it is installed.
2. Casing seams and joints shall be lock-formed and sealed or stitch welded and sealed except as noted, to provide leakage-resistant construction.
3. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
4. Perforated steel shall be adequately stiffened to insure flatness and form. Spot welds shall be painted as required.
5. Fire-Performance Characteristics:
  - a. Silencer assemblies, including acoustic media fill, natural cotton fiber, sealants and acoustical spacers shall have Class 1 flame spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E84, NFPA 255 or UL 723.
6. Material gauge thickness:
  - a. Material gauges noted in other sections are minimums and shall increase as required for the system pressure and velocity classification.
  - b. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.
7. Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, gauge as listed below:
  - a. Rectangular Silencers, including STC-rated models: 22 gauge

8. Inner perforated metal liner shall be supplied in accordance with ASTM A 653/A 653M, G90 galvanized sheet steel in the following gauge thicknesses according to silencer type or connection size:
  - a. Rectangular Silencers: 22 gauge
9. Principal Sound-Absorbing Mechanism:
  - a. Packless (No-Media) Silencers:
    - 1) Models shall not contain absorptive media. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.
  - b. Absorptive (Dissipative) and Film Lined Silencers:
    - 1) Standard Acoustic media:
      - a) Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data.
      - b) Media shall be packed with a minimum of 15% compression during silencer assembly.
      - c) Media shall be resilient such that it will not pull apart during normal applications, and shall resist settling, breakdown, and sagging from vibration. Media shall not rot, mildew, or otherwise deteriorate, and shall have sufficient flexibility to readily form around corners and curved surfaces.
      - d) Media shall not cause or accelerate corrosion of aluminum or steel.
10. Media Protection:
  - a. Film Lined silencers:
    - 1) The acoustic media shall be completely wrapped with polymer film to help prevent shedding, erosion and impregnation.
    - 2) The wrapped acoustic media shall be separated from the perforated metal by a factory-installed acoustically transparent spacer.
    - 3) The spacer shall be flame retardant and erosion resistant.
    - 4) Mesh, screen or corrugated perforated liner will not be acceptable as a substitute for the specified spacer.
    - 5) Silencer manufacturer shall provide a written test report showing silencer assemblies have Class 1 flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723. 3.
11. Shipping Protection:
  - a. Silencers shall be shipped with factory-installed end caps.

12. Capacities and Characteristics:

- a. See duct silencer performance schedule on the mechanical drawings.

13. Refer to the mechanical drawings for locations and configurations.

## 2.7 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Nexus PDQ; Division of Shilco Holdings Inc.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.8 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. METALAIRE, Inc.
  - 4. SEMCO Incorporated.
  - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 36 Insert dimension wide and double wall for larger dimensions.

## 2.9 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Flexmaster U.S.A., Inc.
  - 3. Greenheck Fan Corporation.
  - 4. McGill AirFlow LLC.
  - 5. Nailor Industries Inc.
  - 6. Pottorff; a division of PCI Industries, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
  - 1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - 3. Number of Hinges and Locks:
    - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
    - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

## 2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.

- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd..
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
  - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.11 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Flexmaster U.S.A., Inc.
  - 2. McGill AirFlow LLC.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
  - 4. JP Lamborn.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 10 to plus 160 deg F.
  - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- C. Flexible Duct Connectors:
  - 1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

## 2.12 DUCT ACCESSORY HARDWARE

- 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.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where shown on the drawings. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. Downstream from control dampers, backdraft dampers, and equipment.
  - 2. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links.
  - 3. Control devices requiring inspection.
  - 4. Elsewhere as indicated.
- I. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 by 5 inches.
  - 2. Two-Hand Access: 12 by 6 inches.
  - 3. Head and Hand Access: 18 by 10 inches.

4. Head and Shoulders Access: 21 by 14 inches.
  5. Body Access: 25 by 14 inches.
  6. Body plus Ladder Access: 25 by 17 inches.
- 
- J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
  - K. Install flexible connectors to connect ducts to equipment.
  - L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
  - M. Connect terminal units to supply ducts directly. Do not use flexible ducts.
  - N. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
  - O. Connect flexible ducts to metal ducts with draw bands.
  - P. Install duct test holes where required for testing and balancing purposes.
  - Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
  - R. Install silencer according to manufacturer's written installation instructions.
  - S. Support duct silencers independently from ductwork.
  - T. Ensure duct silencers are installed with airflow arrows in direction of airflow.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  1. Operate dampers to verify full range of movement.
  2. Inspect locations of access doors and verify that purpose of access door can be performed.
  3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  4. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

## SECTION 233423 - HVAC POWER VENTILATORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. In-Line Centrifugal Fans.
  - 2. Roof-Mounted Exhaust Fans
  - 3. Centrifugal Kitchen Roof Ventilators

#### 1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- C. UL Standard: Power ventilators shall comply with UL 705.

### PART 2 - PRODUCTS

#### 2.1 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Acme Engineering & Mfg. Corp.
  - 2. Twin City Fan Company.
  - 3. Greenheck.
  - 4. Loren Cook Company.



- B. Description: In-line, direct drive centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Accessories:
  - 1. As listed on the Mechanical Drawing Schedules.

## 2.2 ROOF-MOUNTED EXHAUST FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Acme Engineering & Mfg. Corp.
  - 2. Twin City Fan Company.
  - 3. Greenheck.
  - 4. Loren Cook Company.
- B. Description: Direct driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Performance & Accessories:
  - 1. As listed on the Mechanical Drawing Schedules.

## 2.3 CENTRIFUGAL KITCHEN ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CaptiveAire.
  - 2. Greenheck.
- B. Description: Direct-driven, as scheduled on the drawings, variable speed control, centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Listings:
  - 1. Type I Exhaust Systems: UL705, UL762, and ULC-S645.
  - 2. Type II Exhaust Systems: UL705
- D. Performance & Accessories:
  - 1. As listed on the Mechanical Drawing Schedules.

- E. Roof curb – Type I Exhaust Systems: Galvanized 20-gauge steel vented curb; mitered and welded corners; Size as required to suit roof opening and fan base.
  - 1. Configuration: Built-in cant and mounting flange.
  - 2. Overall Height: Refer exhaust fan schedule on the drawings.
  - 3. Pitch Mounting: Manufacture curb for roof slope.
  - 4. Metal Liner: Galvanized steel.
- F. Roof curb – Type II Exhaust Systems: Galvanized 20-gauge steel vented curb; mitered and welded corners; Size as required to suit roof opening and fan base.
  - 1. Configuration: Built-in cant and mounting flange.
  - 2. Overall Height: Refer exhaust fan schedule on the drawings.
  - 3. Pitch Mounting: Manufacture curb for roof slope.
  - 4. Metal Liner: Galvanized steel.
  - 5. Gravity backdraft damper

## 2.4 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Totally enclosed, fan cooled.
- C. Type: As listed on the Mechanical Drawing Schedules.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Install units with clearances for service and maintenance.
- C. Support suspended units from structure using threaded steel rods and spring or rubber in shear isolators.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- E. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors except for Type I kitchen hood exhaust fans. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- F. Install ducts adjacent to power ventilators to allow service and maintenance.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Verify lubrication for bearings and other moving parts.
  - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  - 7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 8. Shut unit down and reconnect automatic temperature-control operators.
  - 9. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 233423

## SECTION 233600 - AIR TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Shutoff, single-duct air terminal units.
  - 2. Air terminal unit noise reduction system.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

### PART 2 - PRODUCTS

#### 2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Carnes.
  - 2. METALAIRE, Inc.
  - 3. Nailor Industries Inc.
  - 4. ETI.
  - 5. Price Industries.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch, steel single wall.

1. Casing Lining: Adhesive attached, 3/4-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
  2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  3. Air Outlet: S-slip and drive connections.
  4. Access:
    - a. Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
    - b. Removable panel for upstream access to the reheat coil.
  5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- D. Air Flow Sensor: Multi-point averaging sensor supplied with balancing tees.
- E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
  2. Damper Position: Normally open.
- F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- G. Direct Digital Controls: Furnished and field mounted by the Temperature Control Contractor.
- H. Accessories:
1. Bottom access door.
  2. Control enclosure for field mounted controls.
  3. Hanger brackets.

## 2.2 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

## 2.3 AIR TERMINAL UNIT NOISE REDUCTION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. BRD Noise and Vibration Control, Inc. Hushcore Premium Noise Reduction System.

2. Or other prior approved equal.

B. Configuration:

1. Shall consist of HUSH FLEX™ or HUSH GUARD™ Acoustical Panels. HUSH FLEX™ Acoustical Panels shall consist of a sandwich construction of loaded vinyl barriers and acoustical insulation absorbers all sewn together to make panels sized to fit the Air Terminal Unit as indicated in the detailed installation drawings. The system shall be designed using factory fabricated custom sized panels to be easily removable for periodic maintenance and service needs with panel attachment and removal by Velcro only.
2. HUSHCORE® panels shall be Class "A" flammability per ASTM E-84 for units installed in a plenum rated ceiling.
3. HUSH GUARD™ Acoustical Panels shall consist of a sandwich construction of galvanized outside and inside steel barriers with acoustical insulation fill. The acoustical panels shall be sized to completely encapsulate the Air Terminal Unit.
4. The complete system shall meet all environmental conditions such as temperature and moisture.
5. To assure optimized aerodynamic and acoustic performance as well as proper integration and coordination of the final installation, the HUSHCORE® System shall be supplied by the Air Terminal Unit manufacturer as part of a complete package.
6. All Noise Control Materials Manufacturer's shall deliver a complete submittal of the HUSHCORE® System in compliance with the acoustical performance as listed in this specification.

1. The specified HUSHCORE® HUSH FLEX™ System shall provide the following ASHRAE 130 tested Octave Band Noise Reduction Levels:

| Freq. (Hz)           | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|----------------------|-----|-----|-----|------|------|------|------|
| Noise Reduction (dB) | 3.7 | 1.0 | 3.1 | 9.1  | 16.4 | 15.7 | 14.0 |

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install air terminal unit noise reduction system per the manufacturer's installation guidelines.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  2. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
  3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.3 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

### 3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows.
- B. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Air terminal unit will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 233600

## SECTION 233713 - DIFFUSERS, REGISTERS, GRILLES,

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Diffusers, registers, and grilles.

B. Related Sections:

1. Division 23 Section "Air Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers, registers, and grilles.

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

### PART 2 - PRODUCTS

#### 2.1 GRILLES, REGISTERS AND DIFFUSERS

A. Grilles, Registers and Diffusers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes.
  - b. Krueger.
  - c. Nailor.
  - d. Price Industries
2. Material: As scheduled.
3. Finish: Baked enamel, color selected by Architect, or as scheduled.
4. Mounting: Duct connection.
5. Dampers: Where scheduled.
6. Material: Steel or Aluminum. (as scheduled)



## 2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire or smoke dampers.
- D. Suspend ceiling diffusers from straight-line (opposite corners) to limit weight on VAV in ceiling.
- E. Paint interior of ductwork serving all GRD's black where galvanized ductwork is visible.

### 3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

## SECTION 233723 - HVAC LOUVERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following types of louvers:

- 1. HVAC Louvers.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

#### 2.2 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
  - 1. Use hex-head or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

#### 2.3 HVAC Louvers

- A. Extruded Aluminum Stationary Louvers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Nailor.
  - b. Ruskin.
  - c. Greenheck
  - d. Pottorff.
2. Frame:
  - a. Extruded aluminum, Alloy 6063-T5.
3. Blades:
  - a. Style: As scheduled on the mechanical drawings.
  - b. Material: Extruded aluminum, Alloy 6063-T5.
  - c. Wall Thickness: 0.081 inch nominal.
4. Birdscreen:
  - a. Material: Aluminum – ½" x ½" screen.
5. Finish:
  - a. Kynar 500 Fluoropolymer Coating

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- B. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- C. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- D. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.
- E. Install louvers at locations indicated on the drawings and in accordance with the manufacturer's instructions.
- F. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

G. Install joint sealants in accordance with Division 07.

END OF SECTION 233723

## SECTION 233813 - COMMERCIAL-KITCHEN HOODS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes Type I commercial-kitchen hoods.
- B. Related Requirements:
  - 1. Section 233113 "Metal Ducts – Prefabricated Double Wall Listed Grease Ducts".
  - 2. Section 233423 "HVAC Power Ventilators".

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Filters/baffles.
  - 2. Fire-suppression systems.
  - 3. Lighting fixtures.
- B. Shop Drawings:
  - 1. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
  - 2. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
  - 3. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
  - 4. Show control cabinets.
  - 5. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
  - 6. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 7. Include diagrams for power, signal, and control wiring.
  - 8. Duct Connections: Detail connections between ducts and hoods, including access doors and panels.
  - 9. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

#### 1.3 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.2 HOOD MATERIALS

- A. Stainless-Steel Sheet: ASTM A 666, Type 430.
  - 1. Minimum Thickness: 0.037-inch.
  - 2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
    - a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.
  - 3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).
  - 4. Exposed Surfaces: ASTM A 480/A 480M, No. 3 finish (intermediate polished surface).
  - 5. Exposed Surfaces: ASTM A 480/A 480M, No. 4 finish (directional satin).
  - 6. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- B. Zinc-Coated Steel Shapes: ASTM A 36/A 36M, zinc coated according to ASTM A 123/A 123M requirements.
- C. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial-kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR 177.2600, for use in areas that come in contact with food.
  - 1. Color: As selected by Architect from manufacturer's full range.
  - 2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.
- D. Sound Dampening: NSF-certified, non-absorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.
- E. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

## 2.3 GENERAL HOOD FABRICATION REQUIREMENTS

- A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.
  - 1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
  - 2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
  - 3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
  - 4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
  - 5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.
- B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."
- C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.
- D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.
- E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.
- F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.
- G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.
- H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.
- I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets unless otherwise indicated.
- J. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."
- K. Fabricate enclosure panels to ceiling and wall and end panels as follows:
  - 1. Refer to the mechanical drawings for enclosure and end panels
  - 2. Fabricate panels with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.
  - 3. Wall Offset Spacer: Minimum of 3 inches.

## 2.4 TYPE I EXHAUST HOOD FABRICATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Captive-Aire Systems.
  - 2. Greenheck Fan Corporation.
- B. CONSTRUCTION
  - 1. Construction shall be type 430 stainless steel.
  - 2. Double wall insulated front to eliminate condensation and increase rigidity on wide sizes. The insulation shall have a flexural modulus of 475 EI, meet UL 181 requirements and be in accordance with NFPA 90A and 90B.
  - 3. Hood shall be equipped with a minimum of four connections for hanger rods. Hood lengths greater than 12' will have added hangers.
  - 4. Exhaust duct collar to be 4" high with flange.
  - 5. The grease drain system shall be an enclosed integral part of the hood back and have slopes with an exposed, removable 1/2 grease cup to facilitate cleaning.
  - 6. An integral baffle to direct grease laden vapors toward the exhaust filter bank.
  - 7. Hood shall be furnished with UL classified filters, supplied in size and quantity as required by ventilator.
  - 8. All seams shall be welded and have stainless steel on exposed surfaces.
- C. FILTERS
  - 1. Stainless Steel Captrate Solo filter with hook, ETL Listed. Particulate capture efficiency: 85% efficient at 9 microns, 76% efficient at 5 microns.
- D. OPTIONS
  - 1. Fire Suppression System: UL 300 fire suppression system.
  - 2. Optional perforated supply plenum shall provide make-up air discharged below the cooking equipment.
    - a. Perforated diffuser plates shall be included in the design to provide even air distribution.
    - b. Unexposed surfaces shall be constructed of aluminized steel. Plenum shall be insulated to prevent condensation.
    - c. Perforated Supply Plenum (PSP)
  - 3. Hood Mounted Utility Cabinet - Cabinet can store listed fire suppression system, listed components, pre-wired electrical controls.
- E. ACCESSORIES
  - 1. Wrapper(s) may be installed from the factory or field installed. Wrapper(s) selected:
    - a. Wrapper
  - 2. Miscellaneous option(s) selected:
    - a. Insulation for Top of Hood – Fully insulated top of hood.
    - b. Sensor-Capture Volume – Duct stat installed in the capture volume of the hood.



## 2.5 WET-CHEMICAL FIRE-SUPPRESSION SYSTEM

- A. Description: A pre-engineered, fixed pipe, automatic wet chemical agent fire suppression system for protection of all hazard areas associated with cooking operations, including exhaust hoods, plenums, ductwork, and cooking appliances.
- B. Exhaust hood fire system components to be factory installed.
- C. Cylinder and Valve Assembly
  - 1. The cylinders shall have a tin-nickel alloy plated brass valve with pressure gauge.
  - 2. Wet chemical agent shall be contained in one or more stored pressure DOT/TC rated steel cylinder and valve assemblies.
  - 3. Each cylinder is factory-filled with liquid fire suppressant and pressurized to 200 PSIG at 70°F.
  - 4. Maximum cylinder flow points = 20.
- D. Distribution Nozzles
  - 1. Nozzles shall be located to protect the exhaust ducts, plenums, and all cooking appliances requiring protection.
  - 2. All nozzles shall be equipped with a metal blow off cap. The cap prevents contamination from entering the pipe network and is designed to pop-off upon system discharge, allowing agent to flow to the protected hazard area.
  - 3. All nozzles shall incorporate a stamped part number to easily identify nozzle type.
- E. Distribution System
  - 1. The distribution system shall consist of Copper, Schedule 40 black iron, chrome-plated or stainless-steel pipe and fittings. All exposed piping and fittings must be chrome-plated or stainless steel.
  - 2. Fittings shall be minimum class 150. Galvanized fittings shall not be used.
- F. Suppression System
  - 1. The system control equipment shall be capable of all functions associated with automatically and manually discharging the wet chemical agent from all cylinder and valve assemblies, including automatic shutdown of the heat source or fuel and electrical power to all protected areas upon system discharge.
  - 2. Liquid Fire Suppressant shall be Aqueous Potassium Carbonate (APC).
  - 3. All mechanical components of the actuator kit shall be enclosed.
  - 4. The actuator kit shall be capable of automatic or manual activation means.
  - 5. Supervisory Pressure Switch added to monitor operating system pressure.
  - 6. For manual activation, an electrically operated manual release shall be used to actuate the system manually.
  - 7. For automatic activation, the system will be activated by a Firestat (heat) detector.
- G. Electrical
  - 1. Electrical Division to provide shunt trip breakers at main power panel, or disconnects, as designated by the Electrical Engineer; interconnection provided at hood control panel for the signal to shut down all electricity in and under the exhaust hood. Shunt trips/disconnects to accomplish shut off of electricity in the event of fire system activation by others.

2. Printed circuit board with microprocessor-based controller that provides all the necessary monitoring, timing, and supervision functions required for the reliable operation of the fire system.
3. Independent supervised loops incorporate redundancy and fault detection.
4. Real-time cloud-based monitoring connection provided with system by ownership.
5. Primary power supply, with battery backup for power loss.
6. All wiring must be in accordance to NFPA 70 and the Authority Having Jurisdiction(AHJ).
7. Electric gas valve provided for equipment below exhaust hood. Coordinate size and installation with Plumbing Division.
8. All wiring is to be in accordance with the applicable manufacturer's instructions for the fire alarm control panel, gas shut-off valve, manual reset relay, and contractor supplied shut-off devices.

## 2.6 CASLINK BUILDING MANAGEMENT SYSTEM

### A. GENERAL

1. CASLink is implemented by a SCADA module installed in an electrical control panel or in an electrical cabinet. The SCADA module serves as a gateway to communicate locally gathered data from CASLink-enabled controllers to CASLink's servers. Data is transmitted via a factory installed cellular device, which is integral to the SCADA module.

## 2.7 ELECTRICAL CABINETS AND ENCLOSURES

### A. GENERAL

1. The system includes an LCD screen interface for fan(s) and hood lights control, wash control (if applicable), gas valve reset, programmable schedule, Max Air Override function, Preparation Time mode, Cool Down mode, and diagnostics including VFD status.
2. The LCD screen shows descriptive plain text explaining the functions or values. The LCD screen interface will be installed on the face of the hood, on the face of the utility cabinet, or on the face of a wall mounted control enclosure.

### B. CONSTRUCTION

1. Control enclosure will be NEMA 1 rated and listed for installation inside of the exhaust hood utility cabinet. Control enclosure may be constructed of stainless steel or painted steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.
- B. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.
  2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in "General Hood Fabrication Requirements" Article.
- C. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.
- D. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.
- E. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners unless otherwise indicated.
- F. Install hoods to operate free from vibration.
- G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.
- H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.
- I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.
- J. Set initial temperatures, and calibrate sensors.
- K. Set field-adjustable switches.
- L. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."
- M. Install in accordance with manufacturer's instructions, drawings, written specifications, manufacturer's installation manual, and all applicable building codes.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
  2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  3. Perform hood performance tests required by authorities having jurisdiction.
  4. Perform fire-suppression system performance tests required by authorities having jurisdiction.

- B. Commercial-kitchen hoods will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the commercial-kitchen hoods and associated controls and fire-suppression systems.

END OF SECTION 233813

## SECTION 235216 – CONDENSING BOILERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.
- B. Section includes PVC and CPVC flue vent and combustion air piping.
- C. Related Requirements
  - 1. Section 230993 – “Sequence of Operations for HVAC Controls”.

#### 1.2 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Source quality-control test reports: Indicate and interpret test results for compliance with performance requirements before shipping.
- D. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.
- E. Warranty: Standard warranty specified in this Section.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.
- E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F. AHRI Compliance: Boilers shall be AHRI listed and must meet the minimum efficiency specified under AHRI BTS-2000 as defined by Department of Energy in 10 CFR Part 431.
- G. ANSI Compliance: Boilers shall be compliant with ANSI Z21.13 test standards for US and Canada.
- H. CSA Compliant: Boilers shall be compliant with CSA certification.
- I. Mounting Base: For securing boiler to concrete base.

#### 1.5 COORDINATION

- A. Coordinate size and location of concrete maintenance pads with the general contractor, see drawings for additional requirements.

#### 1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

##### 1. Warranty Period for Fire-Tube Condensing Boilers:

- a. Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship and failure due to thermal shock. Warranty shall commence on the date of Substantial Completion.
- b. Heat exchangers/pressure vessel are warranted against thermal shock for the lifetime of the boiler.
- c. The burner shall carry a five (5) year limited warranty against defective material or workmanship from the date of shipment.
- d. All other components shall carry a one year warranty from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Lochinvar, LLC.
  - 2. Patterson Kelley.
  - 3. Thermal Solutions.
- B. Description: Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- C. Heat Exchanger: The heater exchanger shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel interior with a carbon steel shell and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 Btu's per tube. The Wave Fire Tube shall be manufactured via a liquid impact process. The Wave Fire Tube shall have an OD = 1.654" and a wall thickness = 0.039". The top and bottom tubesheets shall have a minimum thickness = 1/4" (1000-2000) or 3/8" (2500 - 6000). There shall be no overlapping welds with the Wave Fire Tube to tubesheet welds. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger design. Cast iron, aluminum, or copper tube or water tube boilers will not be accepted.
- D. Condensate Collection Basin: Fully welded 316L stainless steel.
- E. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
- F. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm.
- G. The boiler shall be suitable for use with propylene glycol up to 50% concentration level.
- H. Burner: Natural gas, forced draft single burner premix design. Operation of the burner shall not exceed that of 5.7% oxygen level or 40% excess air. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall be removable from the boiler without removing the gas/air manifold.

- I. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
  - 1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- J. Hellcat Combustion System Gas Train: The boiler shall be supplied with a dual body gas valve with regulator.
  - 1. Combustion system shall integrate air and gas dampers along with a variable speed fan to control fuel/air ratio.
  - 2. Systems that rely solely on only one or two methods to adjust the fuel/air ratio shall not be permitted.
- K. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision. Boilers using a pilot for ignition and/or UV scanners for flame supervision shall be deemed unacceptable.
- L. High Altitude: The boiler shall operate at altitudes above sea level. US installations above 2,000 feet shall reference NFPA 54 for de-rate information. Canadian installations above 2,000 feet shall follow all applicable local codes and regulations.
- M. Casing:
  - 1. Jacket: Heavy gauge primed and painted steel jacket with snap-in closures. Jacket panels shall be fully removal; the front door and side panels shall not require tools for removal. The jacket shall be mounted on a steel base with a minimum thickness = 1/4".
  - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 3. Insulation: Minimum 1/2 inch thick, mineral fiber insulation surrounding the heat exchanger.
  - 4. Combustion-Air Connections: Inlet and vent duct collars.
  - 5. Clearances: Boilers shall feature zero (0) clearance to combustibles. Boilers shall have the ability to be placed side by side in multiples with no clearance in between if necessary. Local codes should be considered.
- N. Characteristics and Capacities: See Boiler Schedule on the mechanical drawings.
- O. Safety Relief Valve:
  - 1. Size and Capacity: 50 lb.
    - a. System pressures should be confirmed.
    - b. Custom relief valve sizes can be ordered.
  - 2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
- P. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
- Q. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.



- R. Condensate Trap: Factory supplied condensate trap with condensate trap blocked drain sensor.
- S. Boiler controls shall feature the following standard features:
1. 10" LCD capacitive touch screen display with 1280 x 800 resolution displaying status, modulation percentage, setpoints, and sensor data at a minimum on the home screen. Additional information such as history and parameters can be accessed via the touchscreen display without the need for navigation buttons. A screen saver mode shall be available with the display.
  2. Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0-10V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the boiler heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 20 degrees F and a maximum temperature rise of 60 degrees F.
  3. Password Security: Boiler shall have a password security code for the Installer to access adjustable parameters.
  4. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and a 4 point adjustable reset curve.
  5. Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
  6. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
  7. Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
  8. Domestic hot water priority: Boiler shall make the domestic hot water call for heat a priority over any space heating call and adjust the boiler setpoint to the domestic hot water boiler setpoint.
  9. Domestic hot water modulation limiting: Boiler may be programmed to limit the maximum domestic hot water firing rate to match the input rating of the indirect tank coil.
  10. Domestic hot water night setback: Boiler may be programmed to reduce the domestic hot water tank set point during a certain time of the day.
  11. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
  12. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
  13. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
  14. Five pump control: Boiler shall have the ability to control the boiler pump, system pump, domestic hot water pump, domestic hot water recirculation pump, and the bypass pump.
  15. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.

16. Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
  17. Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.
  18. Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.
  19. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
  20. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running, recycling reporting, and ignition attempts and should be able to view on boiler screen.
  21. Interior service light: Boiler shall feature an LED service light to provide additional illumination to the interior of the boiler.
  22. Refer to Section 230993 "Sequence of Operation for HVAC Controls" for the boiler plant's sequence of operation.
- T. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
1. Lead lag: The Control module shall minimize the number of boilers firing to achieve the heating load.
  2. Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
  3. Front end loading: The Control module shall have the ability to communicate with other Lochinvar boilers featuring the SmartTouch™ and Smart System™ control platforms. This allows for a combination of units that feature condensing and non-condensing operation if so desired.
  4. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.
  5. Redundancy: The Control module shall have a built in feature to continue operating with follower boilers if the Lead boiler is not operational.
- U. Boiler operating controls shall include the following devices and features:
1. Set-Point Adjust: Set points shall be adjustable.
  2. Operating Pressure Control: Factory wired and mounted to cycle burner.
  3. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
  4. Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 10 deg F outside-air temperature, set supply-water

temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

- V. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
  - 1. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
  - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
  - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
  - 4. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
  - 5. Proof of Closure Valve (FCB 6000 only): Proof of closure valve (POC) shall prevent the boiler from firing if the POC valve seat is detected open. Upon a call for heat, once the POC valve seat is proven to be closed, the pre-purge cycle will begin and the POC valve will begin to open.
  - 6. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
  - 7. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
  - 8. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.
- W. Building Automation System Interface: Factory installed Modbus and BACnet MSTP gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.
  - 1. BACnet IP and LonWorks gateways are available as optional equipment.

## 2.2 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
- C. Electrical Characteristics: See Boiler Schedule on the mechanical drawings.

## 2.3 VENTING

- A. Exhaust flue for the FCB/OCB 1000 – 4000 must be Category IV approved PVC, CPVC, PP or stainless steel sealed vent material from one of the approved

manufacturers listed in the Installation and Operation manual. Boilers exhaust vent length must be able to extend up to 150 equivalent feet.

- B. Intake piping for all models must be of approved material as listed in the Installation and Operations manual. Boilers intake pipe length must be able to extend up to 150 equivalent feet.
- C. Boiler venting and intake piping configuration shall be installed per the drawings and the Installation and Operation manual.
- D. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.
- E. Boilers using common venting must contact the factory for sizing.
- F. Refer to manufacturer's Installation and Operations manual for detailed venting instructions and approved vent manufacturers.

## 2.4 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

## 2.5 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedule 40.
  - 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe.
- B. PVC Plastic Pipe: ASTM D 1785, Schedule 40.
  - 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe.

## 2.6 JOINING MATERIALS

- A. Solvent Cements for CPVC Piping: ASTM F 493.
- B. Solvent Cements for PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
  - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in of piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 VENT & COMBUSTION AIR HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Refer to the mechanical drawings for additional hanger and support requirements.
- C. Install the following pipe attachments:
  - 1. Swivel band or adjustable steel clevis hangers for individual horizontal piping 1-1/2 inch or less.
  - 2. Adjustable steel clevis hangers for individual horizontal piping 2 inch and greater in size.
  - 3. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install vinyl-coated hangers for CPVC, PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 5. NPS 6: 48 inches with 3/4-inch rod.
  - 6. NPS 8: 48 inches with 7/8-inch rod.
- E. Install supports for vertical CPVC, PVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.3 VENT & COMBUSTION AIR JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, 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.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.

### 3.4 BOILER INSTALLATION

- A. Install equipment on concrete housekeeping pad.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

### 3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return boiler tapplings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Combustion air and boiler venting:

1. Connect full size to boiler connections. Size and install boiler combustion air and flue venting per the boiler manufacturer installation guidelines. Comply with the manufacturer's installation guidelines for combustion air and flue venting.
  2. Boiler flue venting shall be schedule 40 CPVC piping. Provide and install a stainless steel adapter for connection at the boiler.
  3. The combustion air piping shall be insulated schedule 40 PVC piping.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
  2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: Six (6) months after the date of Substantial Completion, a factory-authorized service representative shall provide one (1) additional on-site visit. This follow up site visit shall validate the initial boiler combustion settings and if needed to further fine tune any applicable system operational programming settings for optimum combustion efficiency / thermal efficiency and seasonal cycle efficiency purposes. A detailed report shall be provided back to the Architect/Engineer and the Owner.
- D. Performance Tests:
1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.
9. Document test results in a report and submit to Architect.

### 3.7 DEMONSTRATION

- A. Engage a factory representative or a factory-authorized service representative for boiler startup and to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

### 3.8 EXTRA MATERIALS

- A. Provide five (5) combustion air filters for each boiler to the Owner at Substantial Completion.

END OF SECTION 235216



## SECTION 237223.23 – PACKAGED, OUTDOOR, HEAT WHEEL ENERGY RECOVERY UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
  - 1. Direct-expansion cooling.
  - 2. Heat recovery wheel.
  - 3. Heating hot water coil.
  - 4. Economizer outdoor- and return-air damper section.
  - 5. Variable frequency drives.
  - 6. Controls.
  - 7. Roof curbs.

#### 1.2 DEFINITIONS

- A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. VVT: Variable-air volume and temperature.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

- 1. Wiring Diagrams: Power, signal, and control wiring.

- C. Sound Power Performance Data.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.
- B. Warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.6 QUALITY ASSURANCE

- A. ARI Compliance:

- 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
  - 3. Certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

- B. ASHRAE Compliance:

- 1. Comply with ASHRAE 15 for refrigerant system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
  - 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
  - 4. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

- E. UL Compliance: Comply with UL 1995 / CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

- F. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- B. Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- C. Unit shall be stored in a clean, dry place protected from construction traffic and construction debris throughout the duration of construction all in accordance with the conditions of construction and with the manufacturer's Installation, Operation, and Maintenance manual.

## 1.8 WARRANTY

- A. Manufacturer shall provide a warranty for a period of 12 months from the date of substantial completion. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.
- B. Special Warranty
  - 1. Warranty Period for Compressors: Manufacturer's standard, but no less than five (5) years from the date of Substantial Completion.
  - 2. Warranty Period for Control Boards: Manufacturer's standard, but no less than three (3) years from the date of Substantial Completion.
  - 3. Warranty Period for Energy Recovery Wheels: Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
  - 1. Aaon
  - 2. Carrier
  - 3. York/JCI
- B. Alternate manufacturers listed above shall take note of specific equipment space restrictions associated with this project. All equipment service and maintenance

requirements shall be maintained within the space provided for the rooftop units. Equipment not of equivalent size to bases of design equipment will not be allowed for use on this project. Equipment weights shall not exceed 10% more than the scheduled weights, refer to the drawings. Contractor shall verify equivalent equipment sizes, weights and performance prior to bidding.

## 2.2 ROOFTOP UNITS

### A. General Description

1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, preheat HW coil, exhaust fans, energy recovery wheels, and refrigeration-only supervisory unit controls.
2. Unit shall be factory assembled and tested including leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

### B. Construction

1. Unit shall be provided with a bottom supply air opening.
2. Unit shall be provided with a bottom return air opening.
3. Supply air opening through the bottom of the unit shall have upturned flanges of at least 1 inch in height around the opening.
4. Return air openings through the bottom of the unit shall have upturned flanges of at least 1 inch in height around the opening.
5. All cabinet walls, floor, access doors and roof shall be fabricated of rigid, impact resistant, double wall, high performance composite panels with G90 galvanized steel on both sides and a closed cell polyurethane foam interior core.
6. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 8 inches of positive or negative static pressure. Deflection shall be measured at the midpoint of the panel height and width.
7. Cabinet leakage shall not exceed 1% of total airflow when tested at 6 inches of static pressure.
8. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

9. Insulation shall have a minimum R-value of 13. Foam shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
10. All cabinet walls, access doors, and roof shall have a thermal break with no metal path from inside to outside.
11. Units with cooling coils shall include double sloped 304 stainless steel drain pans and factory provided p-traps, for field installation. Units with 2 or more cooling coils shall include intermediate 304 stainless steel drain pans between the coils.
12. Roof of the unit shall be sloped to provide complete drainage.
13. Floor of the walk-in service compartment shall have aluminum tread plate covering equipment access areas.
14. Unit shall have rain break overhangs above access doors.
15. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
16. Walk-in service compartment shall provide access to compressors, refrigeration system components, and electrical control panel. Service compartment shall include hinged access door with quarter turn, zinc cast, lockable handles and lighting which is controlled by a wall mounted switch. Access to filters, dampers, cooling coils, preheat coils, exhaust fans, return fans, energy recovery wheels, and supply fans shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
17. Unit shall include lifting spaces along the base of the unit.
18. Unit shall include factory installed open grating on the supply and return air openings.
19. Unit shall include factory installed service lights in all walk-in sections of the unit. Lighting shall be controlled by a wall mounted switch in the service compartment.
20. Unit shall include windows on all access doors to allow visual inspection of the cabinet interior with doors closed.
21. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.
22. Unit shall include a ventilation fan in the service vestibule.
23. Unit shall include a refrigerant leak detection system with three separate factory installed refrigerant sensors.
24. RTU-3 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):

a. Octave Bands:

- 1) 63: 86 / 84
- 2) 125: 89 / 87
- 3) 250: 100 / 93
- 4) 500: 99 / 94
- 5) 1000: 91 / 90
- 6) 2000: 89 / 88
- 7) 4000: 87 / 84
- 8) 8000: 81 / 80

25. RTU-10 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):

a. Octave Bands:

- 1) 63: 88 / 89
- 2) 125: 90 / 90
- 3) 250: 101 / 94
- 4) 500: 100 / 97
- 5) 1000: 91 / 94
- 6) 2000: 89 / 92
- 7) 4000: 88 / 89
- 8) 8000: 82 / 84

C. Electrical

- 1. Unit shall have a 35kAIC SCCR.
- 2. Unit shall be provided with single point power – circuit breaker with non-fused disconnect switch.
- 3. Unit shall be provided with factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.
- 4. Unit shall be provided with phase and brown out protection, which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage, or on phase reversal.
- 5. Lights: Provide LED light strips in all access sections. Wire lights to a single switch. Mount light switch near the electrical panel and wire switch to a terminal strip in the electrical panel for field supplied 120 volt power.

D. Supply Fans

- 1. Unit shall include direct drive, unhooded, backward curved, airfoil aluminum plenum draw through supply fans.
- 2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
- 3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
- 4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency and provided with shaft grounding rings.

E. Exhaust Fans

- 1. Unit shall include 1 direct drive, unhooded, backward curved, aluminum plenum exhaust fans. Exhaust dampers shall be sized for 100% relief.
- 2. Fans and motors shall be dynamically balanced.
- 3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
- 4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
- 5. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
- 6. Motor shall include shaft grounding.

- F. Fan Variable Frequency Drives; factory furnished and installed with the air handling unit. Variable frequency drives shall be from the one of following manufactures and are to have the following minimum features:

1. Manufactures: Allen Bradley, ABB, Danfoss, and Yaskawa.
2. Whether for single fan, dual fan, or fan array applications, a single VFD shall be provided for each supply fan system and each exhaust fan system to ensure proper operation and to optimize operating life.
3. The VFDs shall be mounted internal of unit control/compressor cabinet.
4. Each VFD shall be properly sized, factory mounted, wired to the fan motor, and commissioned to facilitate heating, cooling, and ventilation.
5. VFD to be operable and configured for project specific site altitude.
6. VFD to be provided in NEMA/UL Type 1 Enclosure unless otherwise protected in separate controls enclosure with the cabinet of the air handling unit.
7. The VFD shall include low ambient accessories and devices to allow operation down to minus (-) 20 °F. Low ambient option is to include all necessary factory installed wiring.
8. Keypad Human Interface Module.
9. 3% Input Line Reactor.
10. Protection against under or over voltage and a loss of phase.
11. Ground fault protection.
12. The VFD shall be UL508C listed and CSA certified and conform to applicable NEMA, ICS, NFPA, and IEC standards.

G. Cooling Coils

1. Evaporator Coils
  - a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
  - b. Coils shall have interlaced circuitry.
  - c. Coils shall be hydrogen or helium leak tested.
  - d. Coils shall be furnished with a factory installed electronic expansion valves.

H. Refrigeration System

1. Unit shall be factory charged with R-454B refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be variable speed VFD controlled with on/off tandem compressors. Variable speed circuits shall be interlaced over the entire evaporator face.
4. Compressors shall be mounted in the walk-in service compartment that can be accessed without affecting unit operation. Lockable hinged access door to the compartment shall be fabricated of double wall, high performance composite panels with an R-value of 13 to prevent the transmission of noise outside the cabinet.

5. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
6. Each refrigeration circuit shall be equipped with electronic expansion valve type refrigerant flow control.
7. Each refrigeration circuit shall be equipped with a manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and factory installed replaceable core liquid line filter driers with isolation valves.
8. Unit shall include modulating stages of capacity control.
9. Suction line filters with isolation valves shall be factory installed.
10. Each capacity stage shall be equipped with an adjustable, 20 second delay timer to prevent multiple capacity stages from starting all at once.
11. Each capacity stage shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

#### I. Condensers

1. Air-Cooled Condenser
  - a. Condenser fans shall be vertical discharge, axial flow, direct drive fans.
  - b. Coils shall be designed for use with R-454B refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
  - c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
  - d. Coils shall be hydrogen or helium leak tested.
  - e. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockout.

#### J. Hot Water Preheat Coils

1. Coils shall be certified in accordance with AHRI Standard 410 and be helium or hydrogen leak tested.
2. Coils shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
3. Unit shall include mixed air preheat coils.
4. Control valves shall be field supplied and field installed by the temperature control contractor.

#### K. Filters

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil.
2. Unit shall include 1 inch aluminum mesh pre filters upstream of the outside air opening.
3. Unit shall include a clogged filter switch across the standard filters.
4. Units shall include a Magnehelic gauge mounted in the controls compartment across the standard filters.



L. Outside Air/Economizer

1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return DDC actuator. Unit shall include outside air opening bird screen, outside air hood with rain lip and motorized relief dampers.

M. Energy Recovery

1. Unit shall contain factory mounted and tested energy recovery wheels. The energy recovery wheels shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
2. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with *ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers* and *AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment*. *Cassettes shall be listed in the AHRI Certified Products.*
3. Unit shall include 2 inch thick, pleated panel outside air filters with an ASHRAE MERV rating of 8, upstream of the wheels. Unit shall include 2 inch thick, pleated panel outside air and exhaust air filters with an ASHRAE MERV rating of 8, upstream of the wheels.
4. Hinged service access door shall allow access to the wheel(s).
5. Unit shall contain a factory mounted and tested monolithic aluminum energy recovery wheel with an inverter duty motor and a durable segmented link drive belt composite. Wheel frame shall be constructed with prime G90 hot-dip galvanized steel tested for corrosion resistance of 400 hours of salt spray.
6. Aluminum Energy recovery wheel shall be covered under the standard AAON limited parts warranty; the first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts.
7. Total energy recovery wheels shall be made of corrugated aluminum with a 3A molecular sieve desiccant coating. Coated segments shall be cleanable with air or hot water without degrading the latent recovery.
8. Unit shall include energy recovery wheel defrost control which includes an adjustable temperature sensor and timer wired to periodically stop the wheel rotation, which allows the warm exhaust air to defrost the wheel.
9. Unit shall include energy recovery wheel rotation detection sensors and a set of normally open and normally closed contacts for field indication of wheel rotation.

N. Controls

1. Controls to be field installed DDC Controls by the project's temperature control contractor. Unit to be provided with terminal block and isolation relays.
2. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
3. Unit shall be provided with AAON controls refrigeration supervisor.
4. Unit shall be provided with A2L refrigerant detection system.

#### O. Accessories

1. As further listed on the Packaged Outdoor Roof Mounted Unit With Energy Recovery Schedule on Drawing M0.2.

### 2.3 CURBS

- A. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Roof Curb –Install on roof structure level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.
- B. Install cooling coil condensate drain, minimum connection size, with trap and indirect outlet directly to the roof with the termination approximately 12-inches above the roof deck.
- C. Comply with ANSI Z223.1 and CGA B149.1 or CGA B149.2 for field gas piping.
- D. Install piping through the bottom of the unit with all piping components, valving, devices, etc location immediately in the ceiling space below the unit or as further noted on the mechanical drawings to allow service and maintenance.
- E. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  1. Install ducts to termination at top of roof curb.
  2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb unless otherwise noted or approved by the project's architect and structural engineer.
  3. Connect supply and return ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Flexible duct connectors are to be located below the roof and above the respective ceiling.

### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing. Authorized representative shall also train the facility's maintenance staff on the operation and maintenance of the unit.
- B. Tests and Inspections:
  - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.3 CLEANING AND ADJUSTING

- A. After completing system installation and testing, adjusting, and balancing air handling unit and air-distribution systems, clean filter housings and install new filters.

### 3.4 EXTRA MATERIALS

- A. Provide temporary, throw-away filters for the air handling unit during initial startup and operation. Remove throw-away filters and replace with new filters prior to Test and Balance.
- B. Provide the Owner with one (1) extra set of MERV 8 and MERV 13 filters per filter bank application for each air handling unit at Substantial Completion.

### 3.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters (temporary or permanent) are in place, bearings lubricated, fans have been test run under observation, and owner and engineer have authorized operation.

END OF SECTION 237223.23

## SECTION 237416.11 - PACKAGED ROOFTOP AIR CONDITIONING UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
  - 1. Direct-expansion cooling.
  - 2. Heating hot water coils.
  - 3. Economizer outdoor- and return-air damper section.
  - 4. Variable frequency drives.
  - 5. Controls.
  - 6. Roof curbs.

#### 1.2 DEFINITIONS

- A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. VVT: Variable-air volume and temperature.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

- 1. Wiring Diagrams: Power, signal, and control wiring.

- C. Sound Power Performance Data.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.
- B. Warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.6 QUALITY ASSURANCE

- A. ARI Compliance:

- 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
  - 3. Certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

- B. ASHRAE Compliance:

- 1. Comply with ASHRAE 15 for refrigerant system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
  - 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
  - 4. Unit Energy Efficiency Ratio (EER) shall be equal to or greater than that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

- E. UL Compliance: Comply with UL 1995 / CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

- F. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- B. Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- C. Unit shall be stored in a clean, dry place protected from construction traffic and construction debris throughout the duration of construction all in accordance with the conditions of construction and with the manufacturer's Installation, Operation, and Maintenance manual.

## 1.8 WARRANTY

- A. Manufacturer shall provide a warranty for a period of 12 months from the date of substantial completion. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.
- B. Special Warranty
  - 1. Warranty Period for Compressors: Manufacturer's standard, but no less than five (5) years from the date of Substantial Completion.
  - 2. Warranty Period for Control Boards: Manufacturer's standard, but no less than three (3) years from the date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
  - 1. Aeon.
  - 2. Carrier.
  - 3. York/JCI.
- B. Alternate manufacturers listed above shall take note of specific equipment space restrictions associated with this project. All equipment service and maintenance requirements shall be maintained within the space provided for the rooftop units. Equipment not of equivalent size to bases of design equipment will not be allowed for use on this project. Equipment weights shall not exceed 10% more than the scheduled

weights, refer to the drawings. Contractor shall verify equivalent equipment sizes, weights and performance prior to bidding.

## 2.2 ROOFTOP UNITS

### A. General Description

1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, hot water coils, exhaust fans, and unit controls.
2. Unit shall be factory assembled and tested including leak testing of the DX coils, leak testing of the hot water coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

### B. Construction

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 16. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, exhaust fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs.
11. Unit base shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
12. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.
13. Unit shall include a refrigerant leak detection system with factory installed refrigerant sensors.
14. RTU-1 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
  - a. Octave Bands:
    - 1) 63: 102 / 102
    - 2) 125: 103 / 103
    - 3) 250: 101 / 96
    - 4) 500: 104 / 93
    - 5) 1000: 102 / 96
    - 6) 2000: 100 / 95
    - 7) 4000: 96 / 92
    - 8) 8000: 90 / 89
15. RTU-2 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
  - a. Octave Bands:
    - 1) 63: 94 / 100
    - 2) 125: 94 / 99
    - 3) 250: 95 / 99
    - 4) 500: 95 / 104
    - 5) 1000: 96 / 102
    - 6) 2000: 95 / 98
    - 7) 4000: 93 / 96
    - 8) 8000: 91 / 93
16. RTU-4 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
  - a. Octave Bands:



- 1) 63: 98 / 96
  - 2) 125: 98 / 97
  - 3) 250: 98 / 89
  - 4) 500: 102 / 88
  - 5) 1000: 99 / 90
  - 6) 2000: 95 / 89
  - 7) 4000: 93 / 86
  - 8) 8000: 86 / 83
17. RTU-5 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:
    - 1) 63: 98 / 96
    - 2) 125: 98 / 98
    - 3) 250: 97 / 89
    - 4) 500: 100 / 88
    - 5) 1000: 98 / 91
    - 6) 2000: 96 / 90
    - 7) 4000: 92 / 87
    - 8) 8000: 87 / 84
18. RTU-6 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:
    - 1) 63: 99 / 97
    - 2) 125: 98 / 95
    - 3) 250: 97 / 90
    - 4) 500: 102 / 87
    - 5) 1000: 98 / 89
    - 6) 2000: 96 / 88
    - 7) 4000: 96 / 85
    - 8) 8000: 92 / 82
19. RTU-7 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:
    - 1) 63: 97 / 96
    - 2) 125: 98 / 97
    - 3) 250: 99 / 90
    - 4) 500: 102 / 88
    - 5) 1000: 99 / 91
    - 6) 2000: 95 / 90
    - 7) 4000: 91 / 87
    - 8) 8000: 84 / 84
20. RTU-8 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:

- 1) 63: 97 / 92
  - 2) 125: 96 / 93
  - 3) 250: 97 / 86
  - 4) 500: 101 / 84
  - 5) 1000: 98 / 86
  - 6) 2000: 94 / 85
  - 7) 4000: 91 / 81
  - 8) 8000: 85 / 78
21. RTU-9 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:
    - 1) 63: 96 / 93
    - 2) 125: 95 / 93
    - 3) 250: 96 / 86
    - 4) 500: 99 / 84
    - 5) 1000: 97 / 87
    - 6) 2000: 93 / 86
    - 7) 4000: 89 / 82
    - 8) 8000: 83 / 79
22. RTU-11 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:
    - 1) 63: 98 / 103
    - 2) 125: 99 / 101
    - 3) 250: 98 / 103
    - 4) 500: 97 / 109
    - 5) 1000: 97 / 107
    - 6) 2000: 95 / 101
    - 7) 4000: 91 / 95
    - 8) 8000: 86 / 90
23. RTU-11A Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:
    - 1) 63: 94 / 99
    - 2) 125: 97 / 98
    - 3) 250: 97 / 100
    - 4) 500: 96 / 103
    - 5) 1000: 97 / 102
    - 6) 2000: 95 / 97
    - 7) 4000: 91 / 93
    - 8) 8000: 86 / 89
24. RTU-12 Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:

- |    |       |         |
|----|-------|---------|
| 1) | 63:   | 96 / 95 |
| 2) | 125:  | 97 / 94 |
| 3) | 250:  | 96 / 87 |
| 4) | 500:  | 99 / 85 |
| 5) | 1000: | 96 / 88 |
| 6) | 2000: | 92 / 87 |
| 7) | 4000: | 88 / 83 |
| 8) | 8000: | 83 / 80 |
25. RTU-12A Sound Performance Rating – Maximums: Discharge LW(dB) / Return LW (dB):
- a. Octave Bands:
- |    |       |         |
|----|-------|---------|
| 1) | 63:   | 95 / 94 |
| 2) | 125:  | 94 / 94 |
| 3) | 250:  | 95 / 86 |
| 4) | 500:  | 98 / 85 |
| 5) | 1000: | 95 / 88 |
| 6) | 2000: | 91 / 86 |
| 7) | 4000: | 88 / 83 |
| 8) | 8000: | 82 / 80 |

#### C. Electrical

1. Unit shall have a 35kAIC SCCR.
2. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
3. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.
4. Unit shall be provided with a factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.
5. Lights: Provide LED light strips in all access sections. Wire lights to a single switch. Mount light switch near the electrical panel and wire switch to a terminal strip in the electrical panel for field supplied 120 volt power.

#### D. Supply Fans

1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency and provided with shaft grounding rings.

#### E. Return Fans

1. Unit shall include direct drive, axial flow return fans with blades with adjustable pitch or direct drive, unhooded, backward curved, plenum return fans.

2. Fans and motors shall be dynamically balanced.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Access to return fans shall be through double wall, hinged access doors with quarter turn lockable handles.
5. Unit shall include factory provided and field installed motorized relief dampers or barometric relief dampers.
6. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency with shaft grounding rings.

F. Fan Variable Frequency Drives; factory furnished and installed with the air handling unit. Variable frequency drives shall be from the one of following manufactures and are to have the following minimum features:

1. Manufactures: Allen Bradley, ABB, Danfoss, and Yaskawa.
2. Whether for single fan, dual fan, or fan array applications, a single VFD shall be provided for each supply fan system and each return fan system to ensure proper operation and to optimize operating life.
3. The VFDs shall be mounted internal of unit control/compressor cabinet.
4. Each VFD shall be properly sized, factory mounted, wired to the fan motor, and commissioned to facilitate heating, cooling, and ventilation.
5. VFD to be operable and configured for project specific site altitude.
6. VFD to be provided in NEMA/UL Type 1 Enclosure unless otherwise protected in separate controls enclosure with the cabinet of the air handling unit.
7. The VFD shall include low ambient accessories and devices to allow operation down to minus (-) 20 °F. Low ambient option is to include all necessary factory installed wiring.
8. Keypad Human Interface Module.
9. 3% Input Line Reactor.
10. Protection against under or over voltage and a loss of phase.
11. Ground fault protection.
12. The VFD shall be UL508C listed and CSA certified and conform to applicable NEMA, ICS, NFPA, and IEC standards.

G. Cooling Coils

1. Evaporator Coils
  - a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
  - b. Coils shall have interlaced circuitry.
  - c. Coils shall be hydrogen or helium leak tested.
  - d. Coils shall be furnished with factory installed expansion valves.

H. Refrigeration System

1. Unit shall be factory charged with R-454B refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
7. Where scheduled, unit shall include two variable capacity scroll compressors on the lead refrigeration circuits which shall be capable of modulation from 10-100% of their capacity, and two, two-stage compressors on the lag refrigeration circuits that shall modulate between two capacity settings, 67% and 100%.
8. Where scheduled, unit shall include two VFD controlled, variable speed scroll compressors on the lead refrigeration circuits which shall be capable of modulating refrigerant capacity, and an on/off tandem compressor on the lag refrigeration circuit. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling. The controls shall also include an adjustable, 20 second delay timer for each additional capacity stage to prevent multiple capacity stages from starting simultaneously and an adjustable compressor lock out.
9. Each refrigeration circuit shall be equipped with suction and discharge compressor isolation valves,

#### I. Condensers

##### 1. Air-Cooled Condenser

- a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
- b. Coils shall be designed for use with R-454B refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
- c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
- d. Coils shall be hydrogen or helium leak tested.
- e. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockout.

#### J. Heating Coils

##### 1. Hot Water Heating Coils

- a. Coils shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.

- b. Coils shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
- c. Coils shall be located in the reheat position downstream of the cooling coil.
- d. Control valves to be field supplied by the temperature control contractor and installed by the mechanical contractor.

#### K. Filters

- 1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil.
- 2. Unit shall include a clogged filter switch.
- 3. Unit shall include a Magnehelic gauge mounted in the controls compartment.

#### L. Outside Air/Economizer

- 1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Unit shall include outside air opening bird screen and outside air hood. Unit, except for horizontal series, shall also include barometric relief dampers.
- 2. Damper assembly shall be controlled by spring return DDC actuator.

#### M. Controls

- 1. Controls to be field installed DDC Controls by the project's temperature control contractor. Unit to be provided with terminal block and isolation relays. Coordinate controls with the temperature control contractor prior to bid and throughout construction.
- 2. Outside air damper and return air damper actuators are to be factory furnished and installed. Actuator voltage to be 24-VDC.
- 3. Heating Hot Water Pre-Heat control valves to be field supplied by the temperature control contractor and installed by the mechanical contractor.
- 4. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

#### N. Accessories

- 1. As further listed on the Packaged Outdoor Roof Mounted Unit Schedule on Drawing M0.2.

### 2.3 CURBS

- A. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb

gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

- B. Solid bottom curb shall be factory assembled and fully lined with curb rated 1 inch fiberglass insulation and include a wood nailer strip. Curb shall be sloped to match the roof slope to provide level mounting of the unit.
- C. Refer to the drawings for rooftop units served by vibration isolation curbs and curb requirements. Vibration isolation curbs shall be provided by CDI or Thybar.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Roof Curb –Install on roof structure level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.
- B. Install condensate drain, minimum connection size, with trap and indirect outlet directly to the roof with the termination approximately 12-inches above the roof deck.
- C. Install piping through the bottom of the unit with all piping components, valving, devices, etc location immediately in the ceiling space below the unit or as further noted on the mechanical drawings to allow service and maintenance.
- D. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination at top of roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb unless otherwise noted or approved by the project's architect and structural engineer.
  - 3. Connect supply and return ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Flexible duct connectors are to be located below the roof and above the respective ceiling.

### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing. Authorized representative shall also train the facility's maintenance staff on the operation and maintenance of the unit.
- B. Tests and Inspections:
  - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.

2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.3 CLEANING AND ADJUSTING

- A. After completing system installation and testing, adjusting, and balancing air handling unit and air-distribution systems, clean filter housings and install new filters.

### 3.4 EXTRA MATERIALS

- A. Provide temporary, throw-away filters for the air handling unit during initial startup and operation. Remove throw-away filters and replace with new filters prior to Test and Balance.
- B. Provide the Owner with one (1) extra set of MERV 13 filters for each air handling unit at Substantial Completion.

### 3.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters (temporary or permanent) are in place, bearings lubricated, fans have been test run under observation, and owner and engineer have authorized operation.

END OF SECTION 237416.11



## SECTION 237423.13 - PACKAGED, DIRECT-FIRED, OUTDOOR MAKEUP-AIR UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes direct-fired heating and ventilating unit with evaporative cooling.
- B. Related Sections:
  - 1. 233423 – "HVAC Power Ventilators"
  - 2. 233813 – "Commercial-Kitchen Hoods"

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type and configuration of outdoor, direct-fired heating and ventilating unit.
- B. Shop Drawings: For each type and configuration of outdoor, direct-fired heating and ventilating unit.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. ETL-Listed to the American National Standard/CSA Standard for Gas Unit Heaters And Gas-Fired Duct Furnaces ANSI Z83.4, CSA 3.7.
- E. The Safety Control Board is ETL-Listed to standards UL 60730-2-9, UL 60730-1; CSA E60730-1, and CSA E60730-2-9.

## 1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of direct-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Manufacturer's standard, but not less than one (1) year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements and with an approved prior approval request prior to the bid date, provide products by the following:
  - 1. CaptiveAire
  - 2. Greenheck Corporation
- B. Factory-assembled, prewired, packaged unit consisting of cabinet, supply fan, controls, filters, direct-fired gas burner, and evaporative cooling. Unit to be roof mounted.
- C. 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.
- D. Equipment to be submitted as a prior approval shall take note of specific equipment space restrictions associated with this project. Equipment not of equivalent size to bases of design equipment shall not be allowed for use on this project. Contractor shall verify equivalent equipment sizes prior to submitting prior approval requests.

### 2.2 UNIT CONSTRUCTION

- A. Unit(s) shall be constructed of minimum 20-gauge G-90 galvanized steel riveted together via structural pop-rivets. All metal shall be CNC bent for precise assembly:
  - 1. Base Construction: The base shall be constructed of galvanized steel for improved rigidity. Base shall be structurally reinforced to accommodate the blower assembly and burner.
  - 2. Rigging Provisions: The unit shall have a structural base constructed of minimum 14ga. G-90 galvanized steel, and include lifting points on all four sides.
  - 3. Roof Construction: Roof shall be pitched to allow for proper drainage.
  - 4. Exterior Wall Construction: All exterior walls shall consist of insulated galvanized steel construction.

5. Service Access Doors: All door jambs shall be gasketed around their perimeter. Doors may be mounted via spring actuated, stainless steel hinges with stainless steel rivets, and self-compressing stainless steel pad lockable latches or through removable sliding panels.
  6. Each compartment shall have removable access panels to allow for ease of service and maintainability. Electrical cabinet doors shall be outfitted with schematic/manual pouches formed into the door, along with wiring diagram attached to the interior of the door from the factory.
- B. Entire interior and exterior casing shall be constructed of minimum 20-gauge G-90 galvanized steel with no painting, and shall have undergone a salt spray corrosion test as per ASTM B 117.
  - C. An observation port shall be located on the exterior of the unit for observation of the main flame and pilot flame. All controls, gas valves, modulating controls and electrical components shall be mounted within the burner vestibule. The burner vestibule shall be an integral part of the unit and not extend outside the exterior casing of the unit and not exposed to the main air stream.
  - D. Unit shall be configurable for down (vertical) discharge through unit.
  - E. Unit intake airflow configuration shall be through use of a fresh/outdoor damper.
    1. Damper: Manufacturer shall provide and install on unit, when possible, a two-position, motor-operated damper with internal end switch to energize the blower-starter circuit, when damper is 80% open. Blades shall be a maximum of 6" wide 16-gauge G-90 galvanized steel and shall be made to guarantee the absence of noticeable vibration at design air velocities. Damper blades are to be mounted on friction-free synthetic bearings. Damper edges shall have PVC coated polyester fabric mechanically locked into blade edge. Jamb seals used are flexible metal, compression type. Damper shall exceed AMCA Class 1A standard for low leakage. Damper assembly shall be a single assembly, and outfitted with an integral bird screen and louver/gutter system to divert any drainage through the base of the unit.
    2. Discharge Diffuser: Shall be constructed of G-90 galvanized steel with horizontal and vertical blades capable of four-way diffusion.
    3. Actuator: A single direct drive damper actuator shall be used with spring return to ensure that the outdoor air section opens when not powered.

## 2.3 SUPPLY FANS

- A. All supply fans shall be:
  1. Direct Drive: Blower assembly shall consist of a centrifugal backward inclined, non-overloading wheel secured directly to a heavy-duty, ball bearing type motor via two set screws. The motor and wheel assembly shall be mounted to a heavy gauge galvanized steel frame. The motor shall be controlled by a variable frequency drive, allowing for variable airflow without the need of belts and pulleys.
- B. Blower Motor: Motor shall be a premium efficiency motor available as:

1. Open Drip Proof (ODP) motor driven by a Variable Frequency Drive.
- C. Fans to be selected at or near efficiency peak. Check fan curves provided with job.
- D. Blower and motor assembly shall be dynamically balanced. The entire blower and motor assembly shall be mounted on rubber vibration isolators. Wheels balanced as per AMCA 204-96; Balance Quality and Vibration Levels for fans.
- E. Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings designed for, and individually tested, specifically for, use in air handling applications.

## 2.4 DIRECT FIRED HEAT

- A. The gas burner shall be a direct-fired, pull-through type, using natural gas at an inlet-supply pressure to the unit of 7" w.c. minimum natural gas.
- B. Burner design shall be capable of using natural gas. Burner ignition shall be of the direct-spark design with remote flame sensing at the pilot assembly to detect the presence of flame in the burner.
- C. Direct-sparking sequence shall last through the complete duration of the trial for ignition period for guaranteed light-off. Each burner ignition module shall have LED indicators for troubleshooting and a set of exposed prongs for testing flame indication signal.
- D. Unit should include self-adjusting burner profile plates, which ensure proper air velocity and pressure drop across the burner for clean combustion. Spring-loaded profile plates should react to the momentum of the fresh air stream. No motors or actuators are needed to drive them, nor should they need to be manually set to a specific position. Units should be capable of variable air volume applications.
- E. Each furnace shall have:
  1. The burner shall have non-clogging, stainless steel combustion baffles attached to a ductile aluminum gas-supply section with no moving parts to wear out or fail. The burner shall be capable of 92% combustion efficiency with a maximum turndown ratio of up to 30 to 1.
  2. Stainless steel Quick Seal Connection for gas connection.
  3. Manifold and Input gas pressure gauges.
  4. Inlet pressure gauge installed on the gas manifold (0-35" wc).
  5. Inlet pressure gauge installed on the gas manifold (-5 to 15" wc).

## 2.5 FILTERS

- A. Provide filters as part of unit. All filters shall be furnished and installed to meet the performance requirements set forth in the schedule and as specified under another section of this work.
- B. The filters shall be (2") thick, aluminum mesh coated with super-filter adhesive, aluminum mesh with polyester foam or pleated throw away. Aluminum-mesh filters

shall have aluminum frames with media to be layers of slit and expanded aluminum, varying in pattern to obtain maximum depth loading. Washable 2" filters shall be enclosed in two- piece, die-cut frame with diagonal supports. Frame shall be constructed of heavy-duty beverage board. Filter media is supported on the air leaving side by a metal grid.

- C. All filters shall be installed on tracks for easy removal from the unit.
- D. Shall be either insulated or non-insulated constructed of G-90 galvanized steel with filters supported by internal slides and with removable access panels.
- E. Unit shall have an optional adjustable pressure differential sensor for the filter bank to alert in the event of a clogged filter.

## 2.6 CONTROLS / ELECTRICAL

- A. All controls shall be pre-wired and housed in an insulated electrical cabinet within the unit to protect against risk of condensation.
- B. All direct fired and cooling only units shall be provided with single point electrical connection.
- C. Unit shall be provided with a door safety switch that de-energizes the supply fan when the door is opened.
- D. Units shall be provided with a factory mounted averaging intake air temperature sensor to allow for accurate intake temperature reading regardless of how the OA/RA dampers are positioned.
- E. The electrical cabinet shall be outfitted with the following:
  - 1. Color wiring schematics, laminated to the interior wall of the cabinet doors.
  - 2. Factory mounted disconnect with unit bottom knockouts.
  - 3. A LED backlit, LCD Human-Machine Interface (HMI) shall be mounted within the unit's control cabinet to allow for all set points configurations and system monitoring at the unit. Up to 4 additional space HMIs or wall mount sensors may be assigned to a unit.
  - 4. Space HMI:
    - a. Optional space HMIs allow for full programming capabilities and are outfitted with integral temperature and humidity sensors. Additional HMIs shall be capable of being individually averaged for space temperature/humidity readings. All HMIs shall be wired using standard CAT5/6 cables.
- F. Unit shall be outfitted with a control board to allow for full control of the entire unit.
- G. Provide onboard air flow switch located on MUA control board to sense airflow.
- H. All unit controls shall be compatible with BACnet and LonWorks based building management systems.

- I. All units shall be outfitted with CASLink cloud based monitoring, which monitors every point of operation. Provides configurable automated fault alert e-mails, and remote control capabilities.
- J. Integrated cellular module to provide remote connection to monitoring services to view both real time and historical unit operation. Data shall be stored a minimum of 3 years on the cloud. Data sample rate shall be a maximum of 60 seconds.
- K. Temperature Control System:
  - 1. Discharge Temp Control (Heating) - Unit modulates the burner flame (current supply in the case of electric heating) to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using heating PID controls.
- L. Activation Controls:
  - 1. Activate Based on Intake (Heating) - Unit will activate heating when the intake temperature drops below the desired set point.
  - 2. Activate Based on Space (Heating) - Unit will activate heating when the space temperature drops below the desired set point.
  - 3. Activate Based on Both (Heating) - Unit will activate heating when the space AND intake temperature drop below the desired set point.
  - 4. Activate Based on Either (Heating) - Unit will activate heating when the space OR intake temperature drops below the desired set point.
  - 5. Activate Based on Stat (Heating) - Unit will activate heating when the space thermostat sends a 24V signal to W and G on the main control board. Unit will modulate to maintain a constant discharge heat set point.

## 2.7 ROOF CURBS:

- 1. Insulated.
- 2. Full Bottom Corners.
- 3. Refer to drawings for height.

## 2.8 VARIABLE FREQUENCY DRIVES

- A. Provide Variable Frequency Drive for speed control on all non-ECM direct drive supply fans.
- B. All VFDs shall provide the following inherent protections:
  - 1. Phase protection.
  - 2. Brownout protection.
  - 3. Overload/Overheat protection.
  - 4. Soft starts to protect bearings/hardware.
  - 5. Low & High voltage & over-torque protections.

## 2.9 EVAPORATIVE COOLER

- A. Refer to the drawings for evaporative cooler to be provided with the unit.

## 2.10 ACCESSORIES

- A. Refer to the drawings for accessories to provide with the unit.

## 2.11 CAPACITIES AND CHARACTERISTICS

- A. Refer to the drawings for capacities and characteristics.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine all areas and conditions under which packaged units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

## 3.2 INSTALLATION

- A. Install units in accordance with manufacturer's instructions, drawings, written specifications, manufacturer's installation manual and all applicable building codes.
- B. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."
- C. Install controls and equipment shipped by manufacturer for field installation with direct-fired heating and ventilating units.

## 3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
  - 1. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping. Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service.
- B. Water and Drain:
  - 1. Comply with requirements in Section 221116 "Domestic Water Piping" for piping and accessories for water supply connections to the unit.
  - 2. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.
  - 3. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.
- C. Duct Connections: Connect outside air and supply air ducts to the direct-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

#### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. System start-up shall be performed by a factory-trained service technician.

#### 3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

#### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

#### 3.7 EXTRA MATERIALS

- A. Provide with one (1) extra set of filters and evaporative cooler media and give to the owner at substantial completion.

END OF SECTION 237423.13



## SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Split-system air-conditioners.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- 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. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period:

- a. For Compressors: 10 years limited parts warranty from date of Substantial Completion.
- b. For Parts: 10 years limited parts warranty from date of Substantial Completion.
- c. For Labor: One year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SPLIT-SYSTEM AIR-CONDITIONERS (CRU-1/CU-1 THROUGH CRU-6/CU-6)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Daikin
  - 2. Fujitsu
  - 3. Hitachi
  - 4. Mitsubishi Electric & Electronics USA, Inc..
- B. Indoor Units 5 tons or Less:
  - 1. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
  - 2. Outdoor Unit General:
    - a. The outdoor unit capacity shall be matched to the indoor unit to ensure optimal performance and load handling as per the design requirements. If not matched properly, it will cause communication issues.
    - b. The outdoor unit shall be factory assembled, piped, wired, and run-tested prior to shipment.
    - c. An integrated electronic control board shall manage all operational functions and interface with the indoor unit.
    - d. All control functionalities should be pre-configured at the factory except for Control Box (Capacity Dipswitch must be set)
    - e. The unit shall support low ambient cooling operation down to -40°F (-18°C).
    - f. The unit shall support low ambient heating operations down to -13°F (-25°C).
    - g. The unit shall support no ambient temperature cut-off.
    - h. The outdoor unit shall have enhanced defrost to ensure cold climate-high humidity operations.
    - i. The outdoor unit shall have a sound pressure rating not exceeding 59 dB(A) under standard conditions.
    - j. The system should utilize a single refrigerant circuit and be factory charged with R-32 refrigerant.
    - k. The system shall adopt a DC motor with 16-speed control, enabling precise airflow adjustment and enhanced energy efficiency.
    - l. The system shall support four-direction piping options for flexible installation in various site conditions.
    - m. The system shall include a base pan heater installed on the outdoor unit chassis to prevent ice buildup and enhance heating capacity in low ambient conditions.

- n. The system shall utilize advanced multi pulse control to pre-heat the compressor in low ambient conditions, ensuring reliable cold-weather startup and operation.
  - o. The unit shall be equipped with an electrical box enclosure that protects against dust, moisture, and physical damage, ensuring reliable operation, easier maintenance, regulatory compliance, and extended component lifespan.
  - p. The system shall be VRF H-Link compatible for both indoor and outdoor units, with no adapter required for integration into centralized control networks.
  - q. The systems shall include control board I/Os on indoor and outdoor units to support flexible application control.
  - r. The system shall include a large accumulator for liquid mitigation protection to the compressor.
  - s. The system shall have belt heaters around the compressor and accumulators.
  - t. The internal refrigeration components of the condensing units shall be fully insulated to allow for harsh cold climate operation.
  - u. The Outdoor unit shall not require filter Dryer for installation.
  - v. The Outdoor unit shall be installed in elevations not exceeding 2000m (6562ft)
3. Outdoor Unit Cabinet:
- a. The outdoor unit casing shall be constructed from galvanized steel and finished with a baked enamel coating. The cabinet shall include removable service panels to provide access to all major components for maintenance and servicing.
  - b. Outdoor units shall be equipped with a rigid mounting base to ensure the unit remains secure and stable during operation, including under vibration and wind loading conditions.
  - c. The outdoor units shall be wind-load certified up to 186 mph (up to 50 feet in height), in compliance with:
    - 1) 2023 Florida Building Code – Mechanical Section 301.15
    - 2) Florida Building Code – Building Chapter 16
    - 3) ASCE 7-22 Minimum Design Loads and Associated Criteria for Buildings and Other Structures
  - d. The outdoor coil shall be protected with Bluefin hydrophilic coating, a factory-applied corrosion-resistant treatment. The coating shall be tested in accordance with ASTM B-117 salt spray test procedures for a minimum of 500 hours to ensure durability in coastal and corrosive environments.
  - e. The condensing unit shall include multi-point diagnostics, accessible via a user-friendly service board located at the front of the unit. This board will feature a connection port for our PSH-4 Service Checker Diagnostic tool.
    - 1) Monitoring real-time operation data
    - 2) Displaying fault codes for efficient troubleshooting
    - 3) Record Operational Data and Export
    - 4) Startup & Diagnostic support
  - f. The condensing unit shall be required to use a front Wind baffle to provide adequate protection against wind chill. They shall be ordered separately.
  - g. The condensing unit shall include optional side and back wind baffles for additional reliable operation in extreme weather conditions.

- h. The condensing unit shall include the following factory-installed safety and control devices:
  - 1) Pressure Switch – for high/low refrigerant pressure protection.
  - 2) Discharge Gas Thermistor – to monitor and protect against compressor overheating.
  - 3) Power Source Fuse Capacitor – to safeguard electrical components from surges and faults.
- i. The condensing unit shall provide Continuous ambient operation- No Hard Cut-off.
- 4. Outdoor Unit Piping:
  - a. The condensing unit shall be properly installed with Mechanical Flared Fittings.
  - b. The system shall be capable of operation within the maximum refrigerant piping lengths as published in the manufacturer's performance tables.
  - c. The condensing unit shall support operation with the maximum vertical separation (height difference) between indoor and outdoor units, as specified by the manufacturer.
  - d. All refrigerant lines between the outdoor and indoor units (Discharge, Suction) shall be field-installed and individually insulated to prevent energy loss and condensation.
  - e. Stop valve built with 4-directional outlet piping for easier pipe installation. The refrigerant pipes can connect the stop valves from the front and right, rear and bottom of the unit.
- 5. Outdoor Unit Fan:
  - a. The condensing unit shall be equipped with Direct Drive Propeller Fan(s) for energy-efficiency and quiet operation. Single for will be equipped for small cabinet, Dual Fan for Large Cabinet.
  - b. A steel wire air outlet fan guard grill shall be provided to ensure personnel safety and prevent contact with moving parts while still allowing for maximum airflow.
  - c. The fan shall be configured for horizontal discharge airflow, drawing air from the rear of the unit and discharging it through the front, with the fan located in front of the condensing coil.
- 6. Outdoor Unit Coil Information:
  - a. A condensate base pan with built in heater and a drain connection shall be located beneath the coil to manage water runoff during defrost cycles.
  - b. The outdoor coil shall be constructed using a multi-pass cross-finned tube configuration, with aluminum fins and copper tubing.
  - c. The coil shall be protected by a pre-coated metal guard to prevent physical damage and extend service life.
- 7. Outdoor Unit Sound:
  - a. The condensing unit shall operate with sound pressure levels as low as 49 dB(A) under optimal conditions, ensuring quiet performance suitable for residential and light commercial applications.
- 8. Outdoor Unit Compressor:
  - a. Each outdoor unit shall include a digitally controlled, inverter-driven rotary, and best in class R32 compressor.
  - b. The compressor shall modulate its speed to match the exact room load conditions, improving energy efficiency and reducing operating costs while improving service life of the compressor.

- c. Compressors shall be factory-mounted with rubber grommets to minimize vibration transmission and ensure long-term reliability.
  - d. The compressor shall feature low torque fluctuation, low vibration, and a wide rotational speed range.
  - e. Compressor capacity shall be automatically modulated by varying refrigerant flow to meet real-time heating or cooling demands.
  - f. Unit shall be equipped with electric belt heaters around the compressor and wrapped internally with insulation for cold climate operation.
9. Outdoor Unit Refrigerant:
- a. The condensing unit shall be factory-charged with R-32 refrigerant.
  - b. Condensing Unit is factory charged for up to 99 ft of pipe run, but field charging may be required depending on the installed piping length and elevation, in accordance with manufacturer guidelines.
10. Outdoor Unit Electrical:
- a. The unit shall be capable of operating within a voltage range of 187–253V, ensuring compatibility with standard U.S. electrical systems.
11. Outdoor Unit Performance:
- a. Each unit shall meet the performance criteria specified in the mechanical schedules, based on nominal operating conditions.
12. Indoor Unit General:
- a. The wall-mounted indoor unit shall be installed and matched with a DFS heat pump or cooling-only outdoor unit of the same capacity, as recommended by the manufacturer.
  - b. The indoor unit shall communicate with the outdoor unit via 24VDC control wiring.
  - c. The unit shall be mounted using a wall bracket, which shall be supplied with the unit.
  - d. The unit shall be factory assembled, piped, wired, and run-tested prior to shipment.
  - e. The unit and refrigerant piping shall be pre-charged with dehydrated air (nitrogen) at the factory.
  - f. A wireless remote controller shall be included with the unit.
  - g. The unit shall include a self-diagnostics function for service and maintenance.
  - h. The unit shall be designed for use with R-32 refrigerant.
  - i. The unit and refrigerant pipes shall be charged with nitrogen prior to shipment.
  - j. The unit shall include a 24-hour timer for automatic on/off scheduling.
  - k. The unit shall include an emergency button to start/stop operation and reset the filter indicator.
  - l. Systems shall include control board I/Os on indoor and outdoor units to support flexible application control.
13. Indoor Unit Performance:
- a. Each wall-mounted unit shall meet the performance criteria specified in the mechanical schedules.
  - b. System performance shall be rated in accordance with AHRI 210/240-2023 test conditions for Unitary Air Conditioning and Air-Source Heat Pump Equipment.
14. Indoor Unit Cabinet:
- a. The indoor unit shall be mounted to a separate back plate, which shall be included with the unit.

- b. The front panel shall be removable for access to wiring and internal components.
- c. The unit shall support multi-directional refrigerant piping.
- d. The unit shall support multi-directional drain piping.
- e. The cabinet shall include an integrated infrared sensor to receive commands from the wireless remote controller.
- f. The Wall mounted unit shall include the following factory-installed safety and control features:
  - 1) Control Circuit Fuse Capacitor
  - 2) Freeze Protection Thermostat
  - 3) Thermostat Differential Control
- g. Indoor Unit Fan:
  - 1) The unit shall be equipped with a brushless DC fan motor.
  - 2) The fan shall support multiple speed settings.
  - 3) A turbo mode shall be available for rapid cooling or heating.
  - 4) The fan assembly shall include a cross-flow fan with skewed blades, direct-driven by a single motor.
  - 5) A motorized air louver shall be provided with both static position selection and automatic swing in the up/down direction.
  - 6) Side-to-side airflow control shall be standard via an integrated air guide.
  - 7) Unit shall include a low-noise fan design for smooth, quiet airflow.
- 15. Indoor Unit Coil:
  - a. The indoor coil shall consist of stamped aluminum louvered fins on copper tubing for enhanced heat transfer.
  - b. Coil fins shall be treated with a corrosion-resistant coating.
  - c. All refrigerant lines shall be field-installed and individually insulated.
  - d. A non-metallic condensate drain pan with factory-installed drain connections shall be located beneath the coil.
- 16. Indoor Unit Filter:
  - a. Return air shall be filtered using a factory-supplied, removable, washable filter screen.
- 17. Indoor Unit Sound:
  - a. The unit shall operate with a maximum sound pressure level of 47 dB(A) at the highest fan speed.
- 18. Indoor Unit Electrical:
  - a. The indoor unit shall operate on 208–230V, 1-phase, 60 Hz power.
- 19. Indoor Unit Control:
  - a. The Wall mounted unit shall be supplied with a wireless handheld controller.
  - b. The indoor circuit board shall process and receive sensor data, including coil temperature, return air temperature, and setpoint commands from the remote control to effectively communicate demand to the outdoor unit for proper load control.
  - c. Units shall have optional wired remote control allowing for provide on/off control, temperature setpoint adjustment, louver controls, fan speed selections, mode settings, function settings, and service settings.
  - d. Controllers shall include multiple language support.
  - e. Wired Controller shall be able to control multiple units at the same time.

- f. Units shall be equipped with Frost Wash 2.0 Self Cleaning. This shall allow the indoor coil to eliminate up to 99% of Bacteria, Virus, Mold, and other contaminants.
- g. The indoor unit shall have an optional Wi-Fi adapter to connect to airCloud Go application. Units shall be able to be monitored and controlled remotely from any location.
- h. Units shall have optional central controllers to be able to monitor multiple systems.
- i. Shall Include auxiliary heater setting for Baseboard and emergency heating control.
- j. The system shall be VRF H-Link compatible for both indoor and outdoor units, with no adapter required for integration into centralized control networks.
- k. Controllers shall include Celsius or Fahrenheit settings

20. Accessories: As scheduled on the drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified on the drawings.
- D. Install and connect refrigerant piping per the manufacture requirements and Section 232300 "Refrigerant Piping".
- E. Install to comply with all Code and manufacturer A2L refrigerant requirements.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

- B. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

#### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

#### 3.5 EXTRA MATERIALS

- A. Provide one extra set of filters for each unit.

END OF SECTION 238126



## SECTION 238239 - UNIT HEATERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Cabinet unit heaters with centrifugal fans and hot-water coils.
2. Propeller unit heaters with hot-water coils.

#### 1.2 SUBMITTALS

- A. Product Data: Include rated capacities at site conditions, operating characteristics, furnished specialties, and accessories for each product indicated. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Power, signal, and control wiring.
- B. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

### PART 2 - PRODUCTS

#### 2.1 CABINET UNIT HEATERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Airedale, a division of Modine.
  2. Sigma.
  3. Vulcan.
  4. Sterling.

- B. Description: A factory-assembled and -tested unit complying with ARI 440.
- C. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
  - 1. Horizontal Unit, Fully Recessed, Ceiling Mounted, Exposed Bottom Panels: Galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
  - 2. Vertical Unit, Wall Mounted, Exposed Panels: Galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners. Fabricate with extended piping compartment.
  - 3. Refer to mechanical schedules for unit heater configurations: ceiling and wall.
  - 4. Recessing Flanges: Where scheduled, steel, finished to match cabinet.
  - 5. Control Access Door: Key operated.
- D. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.
- E. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- F. Fan and Motor Board: Removable.
  - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
  - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- G. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- H. Electrical Connection: Factory wire motors and controls for a single field connection.

## 2.2 PROPELLER UNIT HEATERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Airedale, a division of Modine.
  - 2. Sigma.
  - 3. Vulcan.
  - 4. Sterling.

- B. Description: An assembly including casing, coil, fan, and motor with adjustable discharge louvers.
- C. Comply with UL 2021.
- D. Cabinet: Removable panels for maintenance access to controls.
- E. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- G. Hot-Water Coil: Test and rate hot-water propeller unit heater coils according to ASHRAE 33. Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
- H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- I. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Type: Permanently lubricated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install unit heaters to comply with NFPA 90A.
- B. Suspend unit heaters from structure with all-thread hanger rods. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for Piping and Equipment."
- C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Install piping adjacent to machine to allow service and maintenance.
- E. Comply with safety requirements in UL 1995.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace malfunctioning units and retest as specified above.

### 3.3 EXTRA MATERIALS

- A. Provide each cabinet unit heater with one (1) extra set of wire framed polyester media filters.

END OF SECTION 238239

## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Alpha Wire Company.
  2. American Insulated Wire Corp.

3. Belden Inc.
4. Cerro Wire LLC.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. General Cable; General Cable Corporation.
8. Senator Wire & Cable Company.
9. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.

1. THHN/THWN for all circuits except for variable frequency circuits.
2. XHHW wire for any variable frequency circuits.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC and Type SO with ground wire. Type MC is only permitted for light fixture whip.

## 2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M.
2. AFC Cable Systems, Inc.
3. Gardner Bender.
4. Hubbell Power Systems, Inc.
5. Ideal Industries, Inc.
6. ILSCO.
7. NSi Industries LLC.
8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
9. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## 2.3 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 NFPA 70.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.
- C. All motor circuits and connections: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-2-THWN-2 or XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN-2-THWN-2 or XHHW-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2 or XHHW-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2 or XHHW-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.

- F. Branch circuits: Type THHN-2-THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed above accessible ceilings: Type THHN-2-THWN-2, single conductors in raceway.
- H. Branch Circuits Concealed in Hard Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. Variable frequency circuits: Type XHHW, single conductors in raceway.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Install all homeruns above accessible ceilings where possible.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."



- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

### 3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
- C. Label all dedicated circuits for equipment with equipment name and room name at both ends of circuit.

### 3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

### 3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance, feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
  - a. All circuits and feeders serving equipment rated at 5HP or 5kW and above.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Thermographic Image Scanning: After the building is occupied by students, but not more than 90 days after Final Acceptance, perform thermographic scanning of each panel feeder termination. Remove box and equipment covers so terminations are accessible to portable thermographic imaging device. Record all results. Correct deficiencies determined during the scan.
  - a. Follow-up Thermographic Scanning: Perform an additional follow-up scan of each termination 11 months after date of Substantial Completion.
  - b. Instrument: Use an thermographic imaging device designed to measure and record temperature and detect significant deviations from normal values. Provide calibration record for device.
  - c. Record of Infrared Scanning: Prepare a certified report that identifies terminations checked and that describes scanning results including recorded images. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

- B. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

## 2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Mechanical-Type Bus-Bar Connectors: Cast silicon bronze, solderless compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Compression-Type Bus-Bar Connectors: Copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- J. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- K. Water Pipe Clamps:
  - 1. Mechanical type, two pieces with zinc-plated or stainless-steel bolts.
    - a. Material: Tin-plated aluminum or Die-cast zinc alloy.
    - b. Listed for direct burial.
  - 2. U-bolt type with malleable-iron clamp and copper ground connector.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

### 3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  1. Feeders and branch circuits.
  2. Lighting circuits.
  3. Receptacle circuits.
  4. Single-phase motor and appliance branch circuits.
  5. Three-phase motor and appliance branch circuits.
  6. Flexible raceway runs.
  7. Armored and metal-clad cable runs.
  8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
  10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

- F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
  2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

### 3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- C. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
    - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
  2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
  3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.

#### 1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.



## PART 2 - PRODUCTS

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Allied Tube & Conduit.
  - 2. Cooper B-Line, Inc.; a division of Cooper Industries.
  - 3. ERICO International Corporation.
  - 4. GS Metals Corp.
  - 5. Metal Ties Innovation.
  - 6. Thomas & Betts Corporation; a member of the ABB Group.
  - 7. Unistrut; an Atkore International company.
  - 8. Wesanco, Inc.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Cooper B-Line, Inc.; a division of Cooper Industries.
  - b. Empire Tool and Manufacturing Co., Inc.
  - c. Hilti, Inc.
  - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
  - e. MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

7. To Light Steel: Sheet metal screws.
  8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  1. Structural members in paths of conduit groups with common supports.
  2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. ARC: Comply with ANSI C80.5 and UL 6A.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Setscrew or compression.
  - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use

to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- D. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.



- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
  - 1. Material: sheet metal.
  - 2. Type: Fully adjustable
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 5. Provide the following floor boxes:
    - a. Floor boxes that include data: Legrand #RFB4E-OG as basis of design. Floor box shall have a duplex receptacle and 2 data ports unless noted otherwise
    - b. Floor boxes without data: Legrand #RFB2E-OG as basis of design. Floor box shall have a duplex receptacle.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- K. Gangable boxes are prohibited.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 1 or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Handholes installed in parking lot or drive lanes shall be traffic rated.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated.

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

- F. Install surface raceways only where indicated on Drawings. Devices within the gymnasiums shall be installed on surface of all precast walls where not cast into wall. Gym walls with furred out walls on backside shall have conduit install in wall.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  5. Change from RNC to GRC before rising above floor.
- I. Stub-ups to Above Recessed Ceilings:
1. Use EMT for raceways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- O. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
  2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a

flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

R. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
  - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

- T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- W. Locate boxes so that cover or plate will not span different building finishes.
- X. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Z. Set metal floor boxes level and flush with finished floor surface. Coordinate finish of floor boxes with interior designer and/or architect
- AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end

of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.



### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

## SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

### 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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.

- B. Related Requirements:

- 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 SLEEVES

- A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
  1. Material: Galvanized sheet steel.
  2. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
    - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

## 2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Advance Products & Systems, Inc.
    - b. CALPICO, Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.
    - e. Proco Products, Inc.
  2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  3. Pressure Plates: Carbon steel.

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

## 2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. HOLDRITE.

## 2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
  2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Provide Sleeves only where required. Not all penetrations require sleeves.
- B. Comply with NECA 1.
- C. Comply with NEMA VE 2 for cable tray and cable penetrations.
- D. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- E. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

- F. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- G. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- H. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

## SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - a. Restraint channel bracings.
  - b. Restraint cables.
  - c. Seismic-restraint accessories.
  - d. Mechanical anchor bolts.
  - e. Adhesive anchor bolts.
- B. Engage an evaluation and design service to analyze all equipment for seismic control requirements and provide all required design of the seismic control systems.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - a. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
  - b. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
  - c. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For each seismic-restraint device.
  - a. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - b. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints.

- c. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
- d. Seismic-Restraint Details:
- e. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
- f. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
- g. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

#### 1.4 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with NFPA 70.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Classification:
  - a. See structural drawings and specifications for additional seismic information on Site Class, Design Category, and response characteristics.

#### 2.2 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



- a. B-line, an Eaton business.
  - b. Hilti, Inc.
  - c. Mason Industries, Inc.
  - d. Unistrut; Part of Atkore International.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.3 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Kinetics Noise Control, Inc.
  - b. Vibration & Seismic Technologies, LLC.
  - c. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

## 2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. B-line, an Eaton business.
  - b. Kinetics Noise Control, Inc.
  - c. Mason Industries, Inc.
  - d. TOLCO; a brand of NIBCO INC.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- E. 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 used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.5 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. B-line, an Eaton business.
  - b. Hilti, Inc.
  - c. Kinetics Noise Control, Inc.
  - d. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in 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

### 3.1 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### 3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
  - a. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - b. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.
- B. Install cables so they do not bend across edges of adjacent equipment or building structure.
- C. 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.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

E. Drilled-in Anchors:

- a. 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 structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
- b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
- c. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
- d. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
- e. Set anchors to manufacturer's recommended torque using a torque wrench.
- f. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 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 or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 ADJUSTING

- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548.16

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

#### 1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

## PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

### 2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
  2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

### 2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

## 2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.5 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
  - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
  - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
  - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
  - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
  - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
- C. Type:
  - 1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the

continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft..
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

## 2.6 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
  1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  2. 1/4-inch grommets in corners for mounting.
  3. Nominal size, 7 by 10 inches.
- D. Warning label and sign shall include, but are not limited to, the following legends:
  1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES." Adjust clearance space based on NEC requirements.
  3. Arc Flash and Shock hazard: "WARNING - Arc Flash & Shock hazard. Appropriate PPE required." Provide labels per NFPA requirements.

## 2.7 INSTRUCTION SIGNS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.



## 2.8 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch. See detail on drawings for additional requirement.

## 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 30-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Power.
  - 2. Lighting
  - 3. Fire alarm
  - 4. Low voltage
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
- D. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
  - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 480/277-V Circuits:

- a. Phase A: Brown.
  - b. Phase B: Orange.
  - c. Phase C: Yellow.
- 4. Color for Neutral: White.
- 5. Color for Equipment Grounds: Bare copper or green.
  - a. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
  - 1. Limit use of underground-line warning tape to direct-buried cables.
  - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
  - 1. Comply with 29 CFR 1910.145.
  - 2. Identify system voltage with black letters on an orange background.
  - 3. Apply to exterior of door, cover, or other access.

- J. Warning Labels for panelboards, load centers and control equipment: Self-adhesive warning labels to read: "WARNING - Arc Flash & Shock hazard. Appropriate PPE required."
- K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
  - 1. Labeling Instructions:
    - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. See detail on drawings for requirements.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label. See detail on drawings for requirements.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

## SECTION 260572 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. The scope of the study includes all new equipment installed as part of this project from the medium voltage transformer to the branch panels. It does not include the disconnects for individual equipment such as HVAC loads.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.3 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.
- B. No electrical distribution equipment will be approved or released for purchase prior to the completion of the study.
- C. Provide recommendations to correct any deficiencies found in the study.
- D. Modify and repeat the study up to three times until all deficiencies are resolved.

#### 1.4 DEFINITIONS

- A. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the medium voltage transformer to the wiring system of the premises served.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.

- B. Other Action Submittals: Submit the following with protective devices submittals. Submittals shall be in digital form.
  - 1. Short-circuit study input data, including completed computer program input data sheets.
  - 2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
    - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
    - b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Short-Circuit Study Specialist.
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

## 1.7 QUALITY ASSURANCE

- 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. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
  - 1. The Specialist shall be one of the following:
    - a. DP Lund Company – Wylie, TX.
    - b. Specialist engaged by equipment manufacturer.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. CGI CYME.
  - 2. EDSA Micro Corporation.
  - 3. ESA Inc.
  - 4. Operation Technology, Inc.
  - 5. Power Analytics, Corporation.
  - 6. SKM Systems Analysis, Inc.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

### 2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Cable size and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
  - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
  - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
  - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- G. Short-Circuit Study Output:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    - a. Voltage.
    - b. Calculated fault-current magnitude and angle.
    - c. Fault-point X/R ratio.
    - d. Equivalent impedance.
  2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    - a. Voltage.
    - b. Calculated symmetrical fault-current magnitude and angle.
    - c. Fault-point X/R ratio.
    - d. Calculated asymmetrical fault currents:
      - 1) Based on fault-point X/R ratio.
      - 2) Based on calculated symmetrical value multiplied by 1.6.
      - 3) Based on calculated symmetrical value multiplied by 2.7.
  3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    - a. Voltage.
    - b. Calculated symmetrical fault-current magnitude and angle.
    - c. Fault-point X/R ratio.
    - d. No AC Decrement (NACD) ratio.
    - e. Equivalent impedance.
    - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Obtain all data necessary for the conduct of the study.



1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
  2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
  3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative.
1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  2. Obtain electrical power utility impedance at the service.
  3. Power sources and ties.
  4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
  5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
  6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
  7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
  8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
  9. Motor horsepower and NEMA MG 1 code letter designation.
  10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

### 3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is as required to complete the study for the new equipment only.
- E. 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.

- F. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
  - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- G. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
  - 1. Branch circuit panelboards.

### 3.3 ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

### 3.4 DEMONSTRATION

- A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION 260572

## SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. The scope of the study includes all new equipment installed as part of this project from the medium voltage transformer to the branch panels. It does not include the disconnects for individual equipment such as HVAC loads.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.3 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
  - 1. Study results shall be used to determine coordination of series-rated devices if applicable.
- B. No electrical distribution equipment will be approved or released for purchase prior to the completion of the study.
- C. Provide recommendations to correct any deficiencies found in the study.
- D. Modify and repeat the study up to three times until all deficiencies are resolved.

#### 1.4 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.

- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following with protective devices submittals. Submittals shall be in digital form.
  - 1. Coordination-study input data, including completed computer program input data sheets.
  - 2. Study and equipment evaluation reports.
  - 3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
    - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Specialist.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. The following parts from the Protective Device Coordination Study Report:
      - 1) One-line diagram.
      - 2) Protective device coordination study.
      - 3) Time-current coordination curves.
    - b. Power system data.

## 1.8 QUALITY ASSURANCE

- 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. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
  - 1. The Specialist shall be one of the following:
    - a. DP Lund Company – Wylie, TX.
    - b. Specialist engaged by equipment manufacturer.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CGI CYME.
    - b. EDSA Micro Corporation.
    - c. ESA Inc.
    - d. Operation Technology, Inc.
    - e. Power Analytics, Corporation.
    - f. SKM Systems Analysis, Inc.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report

device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

- a. Arcing faults.
- b. Simultaneous faults.
- c. Explicit negative sequence.
- d. Mutual coupling in zero sequence.

## 2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

- 1) Device tag.
- 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
- 3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

- 1) Adjustable pickups and time delays (long time, short time, ground).
- 2) Adjustable time-current characteristic.
- 3) Adjustable instantaneous pickup.
- 4) Recommendations on improved trip systems, if applicable.

- c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
- 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
  - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
  - 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
  - 4. Plot the following listed characteristic curves, as applicable:
    - a. Power utility's overcurrent protective device.
    - b. Medium-voltage equipment overcurrent relays.
    - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    - f. Cables and conductors damage curves.
    - g. Ground-fault protective devices.
    - h. Motor-starting characteristics and motor damage points.
    - i. Generator short-circuit decrement curve and generator damage point.
    - j. The largest feeder circuit breaker in each motor-control center and panelboard.
  - 5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
  - 6. Provide adequate time margins between device characteristics such that selective operation is achieved.
  - 7. Comments and recommendations for system improvements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

### 3.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is as required to complete the study for the new equipment only.
- E. 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.
- F. Transformer Primary Overcurrent Protective Devices:
  1. Device shall not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- G. Motor Protection:
  1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
  2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.



- I. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- J. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
  - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- K. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following as needed to complete the study for the new equipment only:
  - 1. Electric utility's supply termination point.
  - 2. Switchgear.
  - 3. Unit substation primary and secondary terminals.
  - 4. Low-voltage switchgear.
  - 5. Motor-control centers.
  - 6. Standby generators and automatic transfer switches.
  - 7. Branch circuit panelboards.
- L. Protective Device Evaluation:
  - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
  - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
  - 3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

### 3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
  - 1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
  - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
  - 3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
17. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
  - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
  - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
  - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
  - d. Generator thermal-damage curve.
  - e. Ratings, types, and settings of utility company's overcurrent protective devices.
  - f. Special overcurrent protective device settings or types stipulated by utility company.
  - g. Time-current-characteristic curves of devices indicated to be coordinated.
  - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
  - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

- j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.
- k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

### 3.4 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

END OF SECTION 260573

## SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. The scope of the study includes all new equipment installed as part of this project from the medium voltage transformer to the branch panels. It does not include the disconnects for individual equipment such as HVAC loads.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.3 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.
- B. No electrical distribution equipment will be approved or released for purchase prior to the completion of the study.
- C. Provide recommendations to correct any deficiencies found in the study.
- D. Modify and repeat the study up to three times until all deficiencies are resolved.

#### 1.4 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following with protective devices submittals. Submittals shall be in digital form.
  - 1. Arc-flash study input data, including completed computer program input data sheets.
  - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
    - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Arc-Flash Study Specialist.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
  - 1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
  - 2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

## 1.8 QUALITY ASSURANCE

- 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. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
  - 1. The Specialist shall be one of the following:
    - a. DP Lund Company – Wylie, TX.
    - b. Specialist engaged by equipment manufacturer.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CGI CYME.
  - 2. EDSA Micro Corporation.
  - 3. ESA Inc.
  - 4. Operation Technology, Inc.
  - 5. Power Analytics, Corporation.
  - 6. SKM Systems Analysis, Inc.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

### 2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- C. One-line diagram, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Cable size and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."
- G. Arc-Flash Study Output:
  - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    - a. Voltage.
    - b. Calculated symmetrical fault-current magnitude and angle.
    - c. Fault-point X/R ratio.
    - d. No AC Decrement (NACD) ratio.
    - e. Equivalent impedance.
    - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
  - 1. Arcing fault magnitude.
  - 2. Protective device clearing time.
  - 3. Duration of arc.
  - 4. Arc-flash boundary.
  - 5. Working distance.
  - 6. Incident energy.
  - 7. Hazard risk category.
  - 8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

## 2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
  - 1. Location designation.
  - 2. Nominal voltage.
  - 3. Flash protection boundary.
  - 4. Hazard risk category.
  - 5. Incident energy.
  - 6. Working distance.
  - 7. Engineering report number, revision number, and issue date.

- C. Labels shall be machine printed, with no field-applied markings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted prior to arc-flash study may not be used in study.

### 3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies:
  - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
  - 2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."
- C. Calculate maximum and minimum contributions of fault-current size.
  - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
  - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.
- F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
  - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
  - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions



from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
  - 1. When the circuit breaker is in a separate enclosure.
  - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

### 3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
  - 1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.
  - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
  - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
  - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  - 2. Obtain electrical power utility impedance at the service.
  - 3. Power sources and ties.
  - 4. Short-circuit current at each system bus, three phase and line-to-ground.
  - 5. Full-load current of all loads.
  - 6. Voltage level at each bus.
  - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
  - 8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
  - 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

### 3.4 LABELING

- A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
  1. Motor-control center.
  2. Low-voltage switchboard.
  3. Switchgear.
  4. Medium-voltage switch.

### 3.5 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

END OF SECTION 260574

## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy and switchbox-mounted occupancy sensors.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data

### PART 2 - PRODUCTS

#### 2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Acuity Brands Lighting, Inc.

## 2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Basis of Design - Subject to compliance with requirements, provide products by the following or approved comparable products from another manufacturer:

1. Acuity Brands Lighting, Inc

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
  - a. Sensor: Suitable for mounting in any position on a standard outlet box.
  - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
  - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

D. Ceiling Sensor Type n:

1. Basis of Design: nLIGHT #nCM PDT 9 RJB.
2. Extended Range: 360-degree field of view, with a minimum coverage area of 500 sq. ft..
3. Sensing Technology: Dual-technology.
4. Integral photo sensor
5. Automatic dimming controls.

E. Ceiling Sensor Type n10:

1. Basis of Design: nLIGHT #nCM PDT 10 RJB
2. Extended Range: 360-degree field of view, with a minimum coverage area of 2000 sq. ft..
3. Sensing Technology: Dual-technology.

F. Power Pack Type n:

1. Basis of Design: nLIGHT #nPP16D.

G. Power Pack Type ER:

1. Basis of Design: Sensor Switch #PP16DER.

H. Power Pack Type n16:

1. Basis of Design: Sensor Switch #PP16.

## 2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Basis of Design - Subject to compliance with requirements, provide products by the following or comparable products from another manufacturer:

1. Acuity Brands Lighting, Inc

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, dual circuit.
4. Voltage: Match the circuit voltage; dual-technology type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

## 2.4 INDOOR DAYLIGHT SENSOR

A. Manufacturers: Basis of Design - Subject to compliance with requirements, provide products by the following or comparable products from another manufacturer:

1. Acuity Brands Lighting, Inc. - NLIGHT nRM ADCX

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.

4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. General Space Sensors Light-Level Monitoring Range: 1 to 850 fc with an adjustment for turn-on and turn-off levels within that range.
6. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
7. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
8. Test Mode: User selectable, overriding programmed time delay to allow settings check.
9. Control Load Status: User selectable to confirm that load wiring is correct.
10. Indicator: Two digital displays to indicate the beginning of on-off cycles.

## 2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. nLIGHT Control Cable: Category 6 UTP.
- C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. Install all controls such that they will be easily accessible for future adjustment and maintenance.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied

conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  2. For daylight sensors, verify proper operation. Adjust sensitivity, time delay and deadband settings to suit Owner's operations.
- D. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.
- E. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- F. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

### 3.2 FACTORY START-UP SERVICE AND FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to program, start, test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Operational Test: After installing fixtures, controls, switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  3. Verify proper dimming operation of all fixtures.
  4. Verify proper switching operation of all fixtures.
  5. Verify proper emergency operation of all emergency fixtures and those connected to generator power by simulating loss of normal power.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.



D. Prepare test and inspection reports.

### 3.3 LABELING

A. Occupancy All wall plates for switches and controls shall be engraved with a descriptive name of the load controlled by that device.

### 3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

### 3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain all lighting control systems and devices. Schedule and conduct up to four hours of training time on lighting control systems. Divide the time between two sessions if requested by University personnel. Ask Owner if they want video recordings of the training sessions and provide recordings as requested.

END OF SECTION 260923

## SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  - 3. Include diagrams for power, signal, and control wiring.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.
- B. Qualification Data: For testing agency.
- C. Source quality-control reports.
- D. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company.
3. Siemens Power Transmission & Distribution, Inc.
4. Square D; by Schneider Electric.

### 2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. 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.

C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.

1. Coil Material: Copper or Aluminum.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

## 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated.
  - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound utilizing a vacuum pressure impregnation process to seal out moisture and air.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
  - 1. Finish Color: Gray.
- F. Taps for Transformers 3 kVA and Smaller: None.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
- K. K-Factor Rating: All transformers are to be K-13 rated and shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
  - 1. All transformers shall be a K-factor rating of 13 unless noted otherwise.
  - 2. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  - 3. Indicate value of K-factor on transformer nameplate.
- L. Neutral: Rated 200 percent of full load current for K-factor rated transformers.

- M. Wall Brackets: Wall brackets or floor mounted stands fabricated from design drawings signed and sealed by a licensed structural engineer.

## 2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- B. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Install wall-mounted transformers level and plumb with [wall brackets fabricated by transformer manufacturer] [wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer].
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
  - 2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Install transformers level and plumb on a 4" high concrete base with vibration-dampening supports..
- F. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- G. Secure transformer to concrete base according to manufacturer's written instructions.
- H. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- I. Remove shipping bolts, blocking, and wedges.

### 3.2 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- B. Remove and replace units that do not pass tests or inspections and retest as specified above.
- C. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
  1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

### 3.4 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 262200

## SECTION 262413 - SWITCHBOARDS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

##### B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Detail utility company's metering provisions with indication of approval by utility company.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

##### C. Delegated Design Submittal:

1. For arc-flash hazard study.
2. For arc-flash labels.



### 1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, 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.

### 1.4 Field quality-control reports.

### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.

### 1.7 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
  - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.

### 1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed

interconnection wiring that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### 2.2 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; by Schneider Electric.
2. Eaton
3. ABB
4. Siemens

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Comply with NEMA PB 2.

E. Comply with NFPA 70.

F. Comply with UL 891.

G. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel or fixed, individually mounted.
  2. Branch Devices: Panel mounted.
  3. Sections front and rear aligned.
- H. Nominal System Voltage: As shown.
- I. Main-Bus Continuous: As shown.
- J. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- K. Indoor Enclosures: Steel, NEMA 250, Type 1.
- L. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- M. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- N. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- O. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- P. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
  2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
  3. Tin-plated aluminum feeder circuit-breaker line connections.
  4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
  5. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.

6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  7. Disconnect Links:
    - a. Isolate neutral bus from incoming neutral conductors.
    - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
  8. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- Q. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

## 2.3 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Square D; by Schneider Electric.
- B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- C. Features and Accessories:
  1. Integral disconnect switch.
  2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  3. Indicator light display for protection status.
  4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
  5. Surge counter.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
  1. Line to Neutral: 1200 V for 480Y/277 V.
  2. Line to Ground: 1200 V for 480Y/277 V.
  3. Line to Line: 2000 V for 480Y/277 V.
- F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 1000 V.
3. Line to Line: 1000 V.

G. SCCR: Equal or exceed 200 kA.

H. Nominal Rating: 20 kA.

## 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
  - a. Instantaneous trip.
  - b. Long- and short-time pickup levels.
  - c. Long and short time adjustments.
  - d. Ground-fault pickup level, time delay, and  $I^2t$  response. (1000A and greater).
2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
3. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. MCCB Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - d. Ground-Fault Protection: Integrally mounted or remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
  - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

- h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- C. Fuses are specified in Section 262813 "Fuses."

## 2.5 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
  - 1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound, bushing, or bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
  - 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    - d. Megawatts: Plus or minus 1 percent.
    - e. Megavars: Plus or minus 1 percent.
    - f. Power Factor: Plus or minus 1 percent.
    - g. Frequency: Plus or minus 0.1 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    - j. Contact devices to operate remote impulse-totalizing demand meter.
  - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Ratchets to prevent reverse rotation.
8. Removable meter with drawout test plug.
9. Semiflush mounted case with matching cover.
10. Appropriate multiplier tag.

D. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15-minute integrated demand of totalized system.

## 2.6 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

- B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
- C. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

## 2.8 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Install switchboards and accessories according to NECA 400.
- C. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete." Or Section 033053 "Miscellaneous Cast-in-Place Concrete."
  - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to switchboards.
  - 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- E. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- F. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency



procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

- G. Install filler plates in unused spaces of panel-mounted sections.
- H. Install overcurrent protective devices, surge protection devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- I. Install spare-fuse cabinet.
- J. Comply with NECA 1.

### 3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Acceptance Testing:
    - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    - b. Test continuity of each circuit.
  - 2. Test ground-fault protection of equipment for service equipment per NFPA 70.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Switchboard will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262413

## SECTION 262416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Include evidence of NRTL listing for series rating of installed devices.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 7. Include wiring diagrams for power, signal, and control wiring.
  - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Field quality-control reports.
- C. Panelboard schedules for installation in panelboards.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## 1.5 QUALITY ASSURANCE

- 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 NEMA PB 1.
- C. Comply with NFPA 70.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Incoming Mains Location: Top or Bottom.
- D. Phase, Neutral, and Ground Buses: Copper.
- E. All panelboards fed from a K-13 rated step down transformer shall have a 200% rated neutral.

- F. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Tin-plated Copper.
  - 2. Main and Neutral Lugs: Mechanical type.
  - 3. Ground Lugs and Bus Configured Terminators: Mechanical type.
  - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Series rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

## 2.3 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; by Schneider Electric.
- B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- C. Features and Accessories:
  - 1. Integral disconnect switch.
  - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - 3. Indicator light display for protection status.
  - 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
  - 5. Surge counter.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 120 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 1200 V for 480Y/277 V.
  - 2. Line to Ground: 1200 V for 480Y/277 V.
  - 3. Line to Line: 2000 V for 480Y/277 V.
- F. Protection modes and UL 1449 VPR for 208/120 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V.
  - 2. Line to Ground: 1000 V.
  - 3. Line to Line: 1000 V.
- G. SCCR: Equal or exceed 200 kA.
- H. Nominal Rating: 20 kA.

## 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Existing panelboards are Square D. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Eaton Electrical Sector; Eaton Corporation.
  - 2. General Electric Company; GE Energy Management - Electrical Distribution.
  - 3. Square D; by Schneider Electric.
  - 4. ABB.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only as shown on drawings.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Provide integral surge protection device for panels where indicated on drawings.

## 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Eaton Electrical Sector; Eaton Corporation.

2. General Electric Company; GE Energy Management - Electrical Distribution.
  3. Square D; by Schneider Electric.
  4. ABB.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Provide electronic Long, Short, and Instantaneous (LSI) type for all breakers 200A and greater. Provide ground detection for all breakers over 1000A.
  2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
  3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Receive, inspect, handle, store and install panelboards and accessories according to NECA 407.
- B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
  1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

- I. Comply with NECA 1.

### 3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Warning Labels for panelboards, load centers and control equipment: Self-adhesive warning labels to read: "WARNING - Arc Flash & Shock hazard. Appropriate PPE required."

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.

END OF SECTION 262416



## SECTION 262713 - ELECTRICITY METERING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all metering equipment included in drawings and specifications.
- B. Coordinate final calibration and network connections with University of Montana representative.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts and wiring diagrams.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware.

#### 1.5 QUALITY ASSURANCE

- 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.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

- A. Manufacturers: Subject to compliance with requirements, provide the following:

1. Electro Industries.
2. Shark 250-60-10-V3-D2-INP100-PO1S-X-Mon.
3. Provide additional input cards as required for flow meters.

B. General Requirements for Owner's Meters:

1. Comply with UL 1244.
2. Meters used for billing shall have an accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20.
3. Enclosure: NEMA 250, Type 1 minimum.
4. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
  - a. Type: Split or solid core.
7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

C. The meter shall be UL listed and CE marked.

D. The meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The meter shall perform to spec in harsh electrical applications in high and low voltage power systems.

1. The meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
2. The meter shall accept universal voltage input.
3. The meter's surge withstand shall conform to IEEE C37.90.1.
4. The meter shall be user programmable for voltage range to any PT ratio.
5. The meter shall accept a burden up to 0.36VA per phase, Max at 600V, and 0.014VA at 120 Volts.
6. The meter shall accept a voltage input range of up to 416 Volts Line to Neutral, and up to 721 Volts Line to Line.
7. The meter shall accept a current reading of up to 11 Amps continuous.
8. The meter shall have color-coordinated voltage and current inputs.
9. The meter shall have a phasor diagram that clearly shows wiring status.

E. The meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. The second method shall provide additional termination pass-through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.

1. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
2. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.

3. The meter shall accept a burden of 0.005VA per phase, Max at 11 Amps.
  4. The meter shall begin reading at 5mA pickup current.
  5. Pass through wire gauge dimension of 0.177" / 4.5 mm shall be available.
  6. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.
  7. The meter shall accept current inputs of class 10: (0 to 10) A, 5 Amp Nominal, and class 2 (0 to 2) A, 1A Nominal Secondary.
- F. The meter shall have an accuracy of +/- 0.1% or better for Volts and Amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2%) and ANSI C12.20 (Class 0.2%). The meter shall have a Frequency measurement accuracy of not less than 0.001 Hz.
1. The meter shall provide true RMS measurements of voltage, - phase to neutral and phase-to-phase; and current, per phase and neutral.
  2. The meter shall calculate RMS readings, sampling at over 400 samples per cycle on all channels measured readings continuously with no cycle blind spots.
  3. The meter shall utilize 24 bit Analog to Digital conversion.
  4. The meter shall provide %THD (% of Total Harmonic Distortion). Harmonic magnitude recording to the 40th order shall be available for voltage and current harmonics.
- G. The meter shall provide a simultaneous voltage and current waveform recorder.
1. The meter shall be capable of recording 512 samples per cycle for a voltage sag orswell or a current fault event.
  2. The meter shall provide pre- and post-event recording capability.
  3. The meter shall have a programmable sampling rate for the waveform recorder.
  4. The meter shall have an advanced DSP design that allows power quality triggers to be based on a 1 cycle updated RMS.
  5. The meter shall allow up to 170 events to be recorded.
  6. The meter shall store waveform data in a first-in, first-out circular buffer to insure that data is always being recorded.
- H. The meter shall include a three-line, bright red, .56" LED display.
1. The meter shall fit in both DIN 92mm and ANSI C39.1 round cut-outs.
  2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.
- I. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
- J. Power meter shall include virtual measurement upgrade packs, which shall allow user to upgrade in field without removing installed meter.
1. The Virtual Upgrade packs shall be:
    - a. Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, and I/O Expansion - V1
    - b. Above with 2 Megabytes of memory for Data-logging - V2

- c. Above with Power Quality Harmonics - V3
- 2. These Virtual Upgrade packs must be able to be implemented without physically removing the installed meter.
- 3. Meter shall be a traceable revenue meter, and shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
- K. The meter shall include 2 independent communications ports on the back and face plate, with advanced features.
  - 1. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.
  - 2. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.
  - 3. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a PDA or remote laptop without need for a communication cable.
- L. The meter shall provide user configured fixed window or rolling window demand. This shall allow the user to set up the particular utility demand profile.
  - 1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
  - 2. All other parameters shall offer max and min capability over the user selectable averaging period.
  - 3. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
  - 4. The meter shall provide an update rate of every 6 cycles for Watts, VAR and VA. All other parameters shall be every 60 cycles.
- M. The meter shall support a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available and shall have a burden of less than 11VA. An optional power supply of 18-60 Volts DC shall be available.
- N. The meter shall provide Limits Alarms and Control Capability as follows:
  - 1. Limits can be set for any measured parameter.
  - 2. Up to 16 limits can be set.
  - 3. Limits shall be based on % of Full Scale settings.
  - 4. Manual Relay Control shall be available through software.
  - 5. Relay set delays and reset delays shall be available.
  - 6. Relay control shall be available through DNP over Ethernet with the Ethernet Option card.
- O. The meter shall have data-logging capability with the 2, 3, and 4 Megabyte memory upgrade (Virtual Upgrade packs 2-6). The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter with Virtual Upgrade packs 2-4 shall have six logs; the meter with Virtual Upgrade packs 5 and 6 shall also have the Waveform Log:

1. The meter shall have three historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs.
  2. The meter shall have a log for Limits Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording to 2048 events.
  3. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes.
  4. The meter shall have a log for I/O changes. The I/O Change log shall provide a time-stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.
  5. The meter with Virtual Upgrade packs 5 and 6 shall have a log which is capable of recording a waveform both when a user-programmed value goes out of limit and when the value returns to within limit.
- P. The meter shall have I/O expandability through two Option card slots on the back.
1. The cards shall be capable of being installed in the field, without removing the meter from installation.
  2. The meter shall auto-detect the presence of any I/O Option cards.
  3. The Option card slots shall accept I/O cards in all of the following formats: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Output/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card.
  4. The meter shall be capable of accepting any combination of up to two cards.
    - a. When two Ethernet cards are installed in the meter, an independent IP address and MAC address shall be assignable to each card.
  5. The Ethernet Option Card shall provide the meter with 100BaseT Ethernet functionality. The Ethernet Option card shall:
    - a. Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
    - b. Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously.
    - c. Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously.
    - d. Process data at not more 0.6 KBs to 1.5 KBs.
    - e. Allow auto transmit/receive detection for straight or null RJ45 cables.
    - f. Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.
  6. The 1mA O Option Card shall provide the following features:
    - a. 4 channel, bi-directional 0-1mA outputs.

- b. Assignable to any measured parameter.
  - c. 0.1% of Full Scale accuracy throughout range and load.
  - d. Maximum load impedance to 10k Ohms, with no accuracy losses.
- 7. The 20mA Option Card shall provide the following features:
  - a. 4 channel, 4-20mA outputs.
  - b. Assignable to any measured parameter.
  - c. 0.1% of Full Scale accuracy throughout range and load.
  - d. Maximum load impedance to 850 Ohms, with no accuracy losses.
  - e. Loop powered using up to 24 Volts DC.
- 8. The Relay Output/Status Input Option Card shall provide the following features:
  - a. 2 Relay outputs, 2 Status inputs.
  - b. Status Inputs – Wet/Dry Auto Detect up to 150 Volts DC.
  - c. Trigger on User Set Limits/Alarms (with Virtual Upgrade pack 4).
  - d. Set delays and Reset delays.
- 9. The Pulse Output/Digital Input Option Card shall provide the following features:
  - a. 4 KYZ pulse/4 Status inputs.
  - b. Programmable to any energy parameter and pulse value.
  - c. Programmable to End of Interval pulse.
  - d. Can function for manual relay control and limit based control (with Virtual Upgrade pack 4).
  - e. 120mA continuous load current.
- 10. The Fiber Optic Option Card shall provide the following features:
  - a. Built in logic to mimic RS485 half-duplex bus, allowing the user to daisy chain meters for low installation cost.
  - b. ST Terminated Option.
  - c. Versatile Link Terminated Option.
  - d. Modbus and DNP 3.0 protocols available.
- 11. The IEC 61850 Protocol Ethernet Network Option Card shall provide the following features:
  - a. Integrates into any IEC 61850 network.
  - b. Provides support for Modbus and IEC 61850 protocols simultaneously.
  - c. Configurable for multiple logical nodes.
  - d. Provides buffered and unbuffered reporting.
  - e. Provides dual Ethernet IEC 61850 Protocol Network option cards.
- Q. The meter shall have transformer loss, line loss, and total substation loss compensation.
  - 1. Substation losses shall be programmable for Watts and VARs, and for Ferris and copper losses.

2. The meter shall have CT and PT compensation to set compensation factors for errors in CTs and PTs connected to the meter.
- R. The meter shall have a standard 4-year warranty.
- S. Power meter shall be able to be stored in (-20 to +70) degrees C.
1. Operating temperature shall be (-20 to +70) degrees C.
  2. NEMA 12 faceplate rating shall be available for the power meter.
- T. Provide current transformers that are compatible with the metered load, conductor sizes and rated ampacity.
1. Install current transformers completely around all conductors of measured load.
  2. Verify calibration of CT and final metering results with separate metering device.
- U. The following options shall be available for ordering:

| Model                          | Frequency            | Current Input         | V-Switch™ Pack                                           | Power Supply                      | I/O Slot 1                                                     | I/O Slot 2                                                     |
|--------------------------------|----------------------|-----------------------|----------------------------------------------------------|-----------------------------------|----------------------------------------------------------------|----------------------------------------------------------------|
| Shark®200:<br>Meter/Transducer | -50: 50 Hz<br>system | -10: 10A<br>Secondary | -V1:<br>Multifunction<br>meter only                      | -D2: 90-<br>265<br>Volts<br>AC/DC | -INP100S:<br>100BaseT<br>Ethernet                              | -PO1S: 4<br>Pulses/4 Status<br>Inputs                          |
|                                |                      |                       | -V2: Above<br>& 2<br>Megabytes<br>Data-logging<br>memory |                                   | -INP300S:<br>IEC 61850<br>Protocol<br>Ethernet<br>Network Card | -INP300S:<br>IEC 61850<br>Protocol<br>Ethernet<br>Network Card |
|                                |                      |                       | -V3: Above<br>& Power<br>quality<br>Harmonics            |                                   |                                                                |                                                                |

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.

### 3.2 OWNER COORDINATION

- A. Special coordination is required to make sure all equipment and installation meets the Owner's requirements.
- B. Coordinate all materials and installation with Owner prior to ordering or installing any equipment. Do not order and equipment until the Owner has approved the proposed products. Do not connect any current transformers or start any metering equipment without approval from the Owner's metering representative.
- C. Coordinate final calibration and adjustment of metering equipment with Owner's representative.
- D. Coordinate final connectivity of the metering equipment to the campus network with Owner's representative.

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
  - 2. Turn off circuits supplied by metered feeder and secure them in off condition.
  - 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
  - 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
- C. Electricity metering will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262713



## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

##### A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

#### 1.3 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

##### B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

#### 1.4 CLOSEOUT SUBMITTALS

##### A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

##### A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cooper Wiring Devices, Inc.

2. Hubbell.
  3. Leviton Manufacturing Co., Inc.
  4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. All receptacles serving areas where students and the public can be present shall be Tamper Resistant type.
- D. Devices that are manufactured for use with modular plug-in connectors are to be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  2. Devices shall comply with the requirements in this Section.

## 2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

## 2.4 USB CHARGER DEVICES

- A. Tamper-Resistant, USB Charger Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 1310, and FS W-C-596.

## 2.5 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, non-feed-through type.
  2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
  3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Cooper Wiring Devices, Inc.
  - b. Hubbell.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour/Legrand (Pass & Seymour).

## 2.6 TWIST-LOCKING RECEPTACLES

- A. Match plug configuration.

## 2.7 CORD AND PLUG SETS

- A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## 2.8 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Single Pole:
    - 1) Cooper; AH1221.
    - 2) Hubbell; HBL1221.
    - 3) Leviton; 1221-2.
    - 4) Pass & Seymour; CSB20AC1.
  - b. Two Pole:
    - 1) Cooper; AH1222.

- 2) Hubbell; HBL1222.
- 3) Leviton; 1222-2.
- 4) Pass & Seymour; CSB20AC2.

c. Three Way:

- 1) Cooper; AH1223.
- 2) Hubbell; HBL1223.
- 3) Leviton; 1223-2.
- 4) Pass & Seymour; CSB20AC3.

d. Four Way:

- 1) Cooper; AH1224.
- 2) Hubbell; HBL1224.
- 3) Leviton; 1224-2.
- 4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Cooper Wiring Devices, Inc.
  - b. Hubbell.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Cooper Wiring Devices, Inc.
  - b. Hubbell.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

## 2.9 WALL-BOX DIMMERS

- A. Manufacturers: Basis of design - Subject to compliance with requirements, provide products by the following or comparable products from another manufacturer:

- a. Acuity Brands, Inc.
- B. LED Dimmer Switches: Match dimmer switch with type of load dimmed. Provide proper dimmer type and control wiring for all dimmed loads.
- C. Provide types and features as shown on drawings.
- D. Control: Push button type with up/down buttons and on/off button. Provide number of buttons or channels as required for each dimming application.
- E. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
  - 3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
  - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- F. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

## 2.10 FINISHES

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.
- B. Wall Plate Color: For plastic covers, match device color.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
  - a. Cut back and pigtail, or replace all damaged conductors.
  - b. Straighten conductors that remain and remove corrosion and foreign matter.
  - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
  2. Verify that dimmers used for fan speed control are listed for that application.
  3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

### 3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles. Downstream protection is not permitted.

### 3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use machine printed label on face of plate, and durable wire markers or tags inside outlet box. Machine printed labels must be installed clean and well-secured.
- C. Identify each wall switch with descriptive name of lights controlled by that switch. Provide engraved wall plates with approved identification wording. Submit engraving schedule per Part 1.3B.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Test Instruments: Use instruments that comply with UL 1436.
  2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726



## SECTION 262813 - FUSES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
  - a. Control circuits.
  - b. Motor-control centers.
  - c. Panelboards.
  - d. Switchboards.
  - e. Enclosed controllers.
  - f. Enclosed switches.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Cooper Bussmann; a division of Cooper Industries.
  2. Edison; a brand of Cooper Bussmann; a division of Cooper Industries.
  3. Littelfuse, Inc.
  4. Mersen USA.

## 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  - 1. Type RK-5: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
- B. 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.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

### 3.2 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Molded-case circuit breakers (MCCBs).
  - 4. Enclosures.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, 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.
- B. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
    - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

## 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

## 1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

### 2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

### 2.3 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB Inc.
  - 2. Eaton.
  - 3. General Electric Company.
  - 4. SIEMENS Industry, Inc.; Energy Management Division.
  - 5. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty:
  - 1. Single throw.
  - 2. Three pole.
  - 3. 240 and 600-V ac.
  - 4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
  - 5. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

## 2.4 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. SIEMENS Industry, Inc.; Energy Management Division.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

## 2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
  2. General Electric Company.
  3. NOARK Electric North America.
  4. SIEMENS Industry, Inc.; Energy Management Division.
  5. Square D; by Schneider Electric.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 167 deg F rated wire.
- G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
  2. Long- and short-time pickup levels.
  3. Long- and short-time time adjustments.
  4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

- L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- O. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

## 2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.



- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

### 3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Owner's written permission.
  - 4. Comply with NFPA 70E.

### 3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
  - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

### 3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

### 3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections for Switches:
  1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.

- f. Verify that each fuse has adequate mechanical support and contact integrity.
- g. Inspect bolted electrical connections for high resistance using one of the two following methods:
  - 1) Use a low-resistance ohmmeter.
    - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
    - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

## 2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

### C. Tests and Inspections for Molded Case Circuit Breakers:

#### 1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
  - 1) Use a low-resistance ohmmeter.
    - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
    - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

#### 2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data

- are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
  - e. Determine the following by primary current injection:
    - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
  - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
  - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
  - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
  - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  4. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

- c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
  - 1. Test procedures used.
  - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

### 3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

END OF SECTION 262816

## SECTION 262913 - ENCLOSED CONTROLLERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.

#### 1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Wiring Diagrams: For power, signal, and control wiring.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
- B. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## 1.7 QUALITY ASSURANCE

- 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 NFPA 70.
- C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

# PART 2 - PRODUCTS

## 2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Cerus Industrial, Inc.
    - b. Eaton Electrical Sector; Eaton Corporation.
    - c. General Electric Company.
    - d. Rockwell Automation, Inc.
    - e. Siemens Industry, Inc.



- f. Square D.
  - 2. Configuration: Nonreversing.
  - 3. Surface mounting.
  - 4. Pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Cerus Industrial, Inc.
    - b. Cooper Wiring Devices, Inc.
    - c. Eaton Electrical Sector; Eaton Corporation.
    - d. General Electric Company.
    - e. Rockwell Automation, Inc.
    - f. Siemens Industry, Inc.
    - g. Square D.
  - 2. Configuration: Nonreversing.
  - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type or melting alloy type.
  - 4. Surface mounting.
  - 5. Pilot light.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Cerus Industrial, Inc.
    - b. Cooper Wiring Devices, Inc.
    - c. Eaton Electrical Sector; Eaton Corporation.
    - d. General Electric Company.
    - e. Rockwell Automation, Inc.
    - f. Siemens Industry, Inc.
    - g. Square D.
  - 2. Configuration: Nonreversing.
  - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate

adjustment for duty cycle; external reset push button; bimetallic type or melting alloy type.

4. Surface mounting.
5. Pilot light.

E. Magnetic Controllers: Full voltage, across the line, electrically held.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Cerus Industrial, Inc.
- b. Eaton Electrical Sector; Eaton Corporation.
- c. General Electric Company.
- d. Rockwell Automation, Inc.
- e. Siemens Industry, Inc.
- f. Square D.

2. Configuration: Nonreversing.

3. Contactor Coils: Pressure-encapsulated type.

- a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

6. Solid-State Overload Relay:

- a. Switch or dial selectable for motor running overload protection.
- b. Sensors in each phase.
- c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

7. External overload reset push button.

F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

- G. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cerus Industrial, Inc.
2. Eaton Electrical Sector; Eaton Corporation.

3. General Electric Company.
4. Rockwell Automation, Inc.
5. Siemens Industry, Inc.
6. Square D.
7. Fusible Disconnecting Means:
  - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
  - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
8. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

## 2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
  1. Dry and Clean Indoor Locations: Type 1.
  2. Outdoor Locations: Type 3R.
  3. Kitchen Areas: Type 4X, stainless steel.
  4. Other Wet or Damp Indoor Locations: Type 4.
  5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

## 2.3 ACCESSORIES

- A. Push Buttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.
- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 78 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide

freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Comply with NECA 1.

### 3.2 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### 3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

### 3.5 ADJUSTING

A. Set field-adjustable switches and overload-relay pickup and trip ranges.

B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

### 3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

## SECTION 263213.16 - GAS-ENGINE-DRIVEN GENERATOR SETS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes packaged engine generators for non-emergency use with the following features:
  - 1. Natural gas engine.
  - 2. Gaseous fuel system.
  - 3. Control and monitoring.
  - 4. Generator overcurrent and fault protection.
  - 5. Generator, exciter, and voltage regulator.
  - 6. Outdoor generator-set enclosure.
  - 7. Vibration isolation devices.
- B. Related Requirements:
  - 1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include plans and elevations for engine generator and other components specified.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Identify fluid drain ports and clearance requirements for proper fluid drain.
  - 4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
  - 6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency.

- B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### 1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Caterpillar, Inc.; Electric Power Division.
  - 2. Cummins Power Generation.
  - 3. ASCO.
  - 4. Generac.
  - 5. Kohler Power Systems.
- B. Source Limitations: Obtain packaged engine generators and auxiliary components through one source from a single manufacturer.



## 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Engine generator housing, engine generator, batteries, battery racks, silencers, load banks, and sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.
  - 3. Component Importance Factor: 1.0.
- B. B11 Compliance: Comply with B11.19.
- C. NFPA Compliance:
  - 1. Comply with NFPA 37.
  - 2. Comply with NFPA 70.
  - 3. Comply with NFPA 99.
- D. UL Compliance: Comply with UL 2200.
- E. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.
- F. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - 1. Ambient Temperature: -10 to 104 deg F.
  - 2. Relative Humidity: Zero to 95 percent.
  - 3. Altitude: Sea level to 3500 feet

## 2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.
- C. Power Rating: 200kW/250kVA Industrial.
- D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

- E. Power Factor: 0.8 lagging.
- F. Frequency: 60 Hz.
- G. Voltage: 208 V ac.
- H. Phase: Three-phase, four wire, wye .
- I. Induction Method: Naturally aspirated or turbocharged.
- J. Governor: Adjustable isochronous, with speed sensing.
- K. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
  - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- L. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
  - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- M. Engine Generator Performance:
  - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
  - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
  - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  - 7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load

current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time:

- a. Comply with NFPA 110, Type 10 system requirements.

## 2.4 GAS ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.

- 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
- 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
- 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

- 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
- 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
- 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
- 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
  - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
  - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer: Semicritical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 18 dB at 500 Hz.
  2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 85 dBA or less.
- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 12 or 24-V electric, with negative ground.
1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
  2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  3. Cranking Cycle: 60 seconds.
  4. Battery: Lead acid with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
  5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
  7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
  8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
  9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
    - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
    - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel.

Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## 2.5 GASEOUS FUEL SYSTEM

- A. Natural Gas Piping: See Civil and Plumbing for requirements.
- B. Gas Train: Comply with NFPA 37.
- C. Engine Fuel System:
- D. Natural Gas Vapor-Withdrawal System:
  - 1. Carburetor.
  - 2. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
  - 3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
  - 4. Fuel Filters: One for each fuel type.
  - 5. Manual Fuel Shutoff Valves: One for each fuel type.
  - 6. Flexible Fuel Connectors: Minimum one for each fuel connection.
  - 7. LP gas flow adjusting valve.
  - 8. Fuel change gas pressure switch.

## 2.6 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- C. Provide minimum run time control set for 30minutes with override only by operation of a remote emergency-stop switch.
- D. Comply with UL 508A.
- E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel

mounted on the engine generator. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine generator battery.

- F. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.

G. Control and Monitoring Panel:

1. Digital controller with integrated LCD, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.
  - a. Engine lubricating-oil pressure gage.
  - b. Engine-coolant temperature gage.
  - c. DC voltmeter (alternator battery charging).
  - d. Running-time meter.
  - e. AC voltmeter, for each phase
  - f. AC ammeter, for each phase
  - g. AC frequency meter.
  - h. Generator-voltage adjusting rheostat.
4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication, including the following:
  - a. Cranking control equipment.
  - b. Run-Off-Auto switch.
  - c. Control switch not in automatic position alarm.
  - d. Overcrank alarm.
  - e. Overcrank shutdown device.
  - f. Low water temperature alarm.
  - g. High engine temperature.
  - h. High engine temperature shutdown device.
  - i. Overspeed alarm.
  - j. Overspeed shutdown device.
  - k. Retain instrument in first subparagraph below for gaseous systems with fuel tanks.
  - l. Coolant low-level alarm.
  - m. Coolant low-level shutdown device.
  - n. Coolant high-temperature prealarm.
  - o. Coolant high-temperature alarm.
  - p. Coolant low-temperature alarm.
  - q. Coolant high-temperature shutdown device.
  - r. EPS supplying load indicator.
  - s. Battery high-voltage alarm.
  - t. Low cranking voltage alarm.
  - u. Battery-charger malfunction alarm.
  - v. Battery low-voltage alarm.

- w. Lamp test.
  - x. Contacts for local and remote common alarm.
  - y. Low-starting air pressure alarm.
  - z. Low-starting hydraulic pressure alarm.
  - aa. Remote manual stop shutdown device.
  - bb. Air shutdown damper alarm when used.
  - cc. Air shutdown damper shutdown device when used.
  - dd. Hours of operation.
  - ee. Engine generator metering, including voltage, current, Hz, kW, kVA, and power factor.
- H. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.
- I. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- 1. Overcrank alarm.
  - 2. Coolant low-temperature alarm.
  - 3. High engine temperature prealarm.
  - 4. High engine temperature alarm.
  - 5. Low lube oil pressure alarm.
  - 6. Overspeed alarm.
  - 7. Low fuel main tank alarm.
  - 8. Low coolant level alarm.
  - 9. Low cranking voltage alarm.
  - 10. Contacts for local and remote common alarm.
  - 11. Audible-alarm silencing switch.
  - 12. Air shutdown damper when used.
  - 13. Run-Off-Auto switch.
  - 14. Control switch not in automatic position alarm.
  - 15. Fuel tank derangement alarm.
  - 16. Fuel tank high-level shutdown of fuel supply alarm.
  - 17. Lamp test.
  - 18. Low cranking voltage alarm.
  - 19. Generator overcurrent protective device not closed.
- J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

## 2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.
  - 1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
  - 2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
  - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
  - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
  - 3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
  - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- C. Generator Disconnect Switch: Molded-case type, 100 percent rated.
  - 1. Trip Rating: Matched to generator output rating.
  - 2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.
- D. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:
  - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.
  - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
  - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
  - 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

## 2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.



- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six or 12 lead alternator.
- E. Range: Provide limited range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified
  - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
  - 2. Maintain voltage within 20 percent on one step, full load.
  - 3. Provide anti-hunt provision to stabilize voltage.
  - 4. Maintain frequency within 15 percent and stabilize at rated frequency within 5 seconds.
- I. Alternator Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Battery Heater: Thermostatically controlled.
- K. Coolant Heater: Thermostatically controlled.
- L. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- M. Subtransient Reactance: 12 percent, maximum.

## 2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description:
  - 1. Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 60 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
    - a. Sound Attenuation Level: 2.
- B. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

- C. Load center with circuit breakers for generator accessories such as battery charger, heating elements, etc. 208V, 60A, 22kAIC minimum rating.
- D. Hinged Doors: With padlocking provisions.

## 2.10 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  - 1. Tests: Comply with IEEE 115.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions.
- C. Equipment Mounting:
  - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
  - 3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure engine generator to anchor bolts installed in concrete bases.
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.
- F. Gaseous Fuel Piping:
  - See Civil for requirements
- G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Gaseous Fuel Connections:
  - 1. Connect fuel piping to engines with a gate valve and union and flexible connector.
  - 2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
  - 3. Vent gas pressure regulators outside building a minimum of 60 inches from building openings.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

### 3.3 IDENTIFICATION

- A. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below as specified in the NETA ATS. Certify compliance with test parameters.
  - a. Visual and Mechanical Inspection
    - 1) Compare equipment nameplate data with drawings and specifications.
    - 2) Inspect physical and mechanical condition.
    - 3) Inspect anchorage, alignment, and grounding.
    - 4) Verify the unit is clean.
  - b. Electrical and Mechanical Tests
    - 1) Perform insulation-resistance tests in accordance with IEEE 43.
      - a) Machines larger than 200 hp. Test duration shall be 10 minutes. Calculate polarization index.
      - b) Machines 200 hp or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
    - 2) Test protective relay devices.
    - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
    - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
    - 5) Perform vibration test for each main bearing cap.
    - 6) Verify correct functioning of the governor and regulator.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
  - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
  - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
  - c. Verify acceptance of charge for each element of the battery after discharge.
  - d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust Emissions Test: Comply with applicable government test criteria.

7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
  8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
  9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure and on the property line and compare measured levels with required values.
- F. Coordinate tests with tests for transfer switches and run them concurrently.
  - G. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
  - H. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
  - I. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
  - J. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - K. Remove and replace malfunctioning units and retest/reinspect as specified above.
  - L. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
  - M. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

### 3.6 MAINTENANCE

- A. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in an adequately sized metal toolbox.
- B. Contractor shall provide service and maintenance of engine generator system for one (1) year from date of Substantial Completion at no additional cost to the Owner.

1. This service and maintenance shall be provided in accordance with the recommended maintenance and service for the generator installed and shall include all preventive maintenance, systematic examination, adjustment, inspection, and testing.
  2. Contractor shall, at a minimum, conduct a site visit once every three months to perform inspections, testing, and preventive maintenance. Include additional site visits if recommended by the generator manufacturer's standard maintenance requirements. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
  3. All testing and maintenance required by NFPA 110 shall be performed as part of this maintenance as well. Contractor shall supply all materials and equipment necessary to perform these tests at no additional cost to Owner.
- C. At the completion of the one-year maintenance provided as part of the project, the Contractor shall prepare and offer a maintenance contract to the Owner that meets all required maintenance and service needs for the generator system.
- D. Provide trouble call-back service upon notification by the Owner. Provide onsite response within 4 hours of notification. All call-backs shall be provided at no additional cost to the Owner.
- E. Maintain an onsite log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 263213.16

## SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes interruptible (fast-transfer) central battery equipment rated 600 V and less for emergency lighting:

#### 1.2 DEFINITIONS

- A. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type and rating of central battery equipment unit.
- B. Shop Drawings: For each type and rating of central battery equipment unit.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection.
  - 3. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring.
  - 4. Include elevation, details, and legends of control and indication displays.
  - 5. Include -circuit current (withstand) rating of unit.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around central battery equipment.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Data: For central battery equipment, accessories, and components, from manufacturer.

- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
  - 1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
    - a. Central Battery Equipment (excluding Batteries): Five year.
    - b. Batteries:
      - 1) Full Warranty: 3 years.
      - 2) Pro Rata: Nine years.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Central battery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated central battery equipment shall be tested and certified by an NRTL as meeting ICC-ES AC 156 test procedure requirements.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event.

### 2.2 INTERRUPTIBLE CENTRAL BATTERY EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved products by another manufacturer:
  - 1. Evenlite
  - 2. Online Power
  - 3. Iota; Acuity Brands Lighting, Inc.



B. General Requirements for Interruptible Central Battery Equipment:

1. 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.
2. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924.
3. Comply with the IBC, NFPA 70, and NFPA 101.
4. Comply with NEMA PE 1.
5. Basis of design: IOTA #IIS series 277IN 277OUT ST with OB8 1P277 20AMP ON

C. Performance Requirements:

1. Fast-Transfer Central Battery Equipment: Passive standby (off-line) system. Automatically sense loss of normal ac supply and use a solid-state static switch to transfer load. Transfer in 50 ms or less from normal supply to battery-inverter supply.
2. Automatic Operation:
  - a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
  - b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
  - c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
  - d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
  - e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
  - f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
  - g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
  - h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

D. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
  2. Input Frequency Tolerance: Plus or minus 5 percent of central battery equipment frequency rating.
  3. Synchronizing Slew Rate: 1 Hz per second, maximum.
  4. Minimum Off-Line Efficiency: 95 percent at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or operating condition.
  6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.
  7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F and not exceeding 158 deg F
  8. Ambient Temperature Rating (Batteries): Not less than 32 deg F and not exceeding 104 deg F.
  9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F and not exceeding 104 deg F
  10. Humidity Rating: Less than 95 percent (noncondensing).
  11. Altitude Rating: Not exceeding 3300 feet.
  12. Off-Line Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
- E. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.
- F. Controls and Indication:
1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:
    - a. Normal power available.
    - b. Status of system.
    - c. Battery charging status.
    - d. On battery power.
    - e. System fault.
  2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
    - a. Keypad: In addition to required programming and control keys, include the following:
      - 1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
      - 2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.
      - 3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.

- b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:
  - 1) Real-time clock with current time and date.
  - 2) Tests and Events Logs: Record and store up to 25 tests and events.
    - a) Dates.
    - b) Times.
    - c) Durations.
    - d) Output voltage and currents.
  - 3) Alarm Logs: Record and store up to 25 alarms.
    - a) Dates.
    - b) Times.
    - c) Alarm type.
  - 4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:
    - a) Input and output voltage (V ac) and output current (A ac).
    - b) Battery voltage (V dc) and current (A ac).
    - c) Fault or alarming status (code).
    - d) Power output (VA).
    - e) Inverter load (W).
    - f) Ambient temperature (deg F).
    - g) System run time (cumulative days).
    - h) Inverter run time (cumulative minutes).
  - 5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:
    - a) High/low battery charge voltage.
    - b) High/low input voltage.
    - c) Battery nearing low-voltage condition.
    - d) Battery low voltage.
    - e) High ambient temperature.
    - f) Inverter fault.
    - g) Output fault.
    - h) Output overload.

### 3. Remote Signal Interfaces:

- a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:
  - 1) Fault or status indication.
  - 2) On bypass.
  - 3) Low battery.

- b. Communications Interface: Factory-installed hardware and software to enable a remote PC to program central battery equipment and monitor and display status and alarms using RS-232 port.

G. Self-Protection and Reliability Features:

- 1. Input surge protection by means of SPDs to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
- 2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
- 3. Battery deep-discharge and self-discharge protection; with alarms.
- 4. Battery self-test circuitry; with alarms and logging.

H. Inverter:

- 1. Description: Solid-state, high-frequency, PWM type, with the following operational features:
  - a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
  - b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
  - c. Output Voltage Waveform: Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
  - d. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10seconds.
  - e. Load Power Factor: 0.5 lead to 0.5 lag.

I. Rectifier/Battery Charger:

- 1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
- 2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
- 3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

J. Batteries:

- 1. Description: Lead Calcium batteries.
  - a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.
- 2. Battery Disconnect and OCPD: Manufacturer's standard.

K. Integral Output Disconnecting Means and OCPD:

1. Multiple-Output OCPDs: 12 thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- C. Suspended-Mounted Central Battery Equipment: Suspend central battery equipment from structural ceiling components using hangers, clamps, and associated fittings, designed for types and sizes of units to be supported. Provide support devices complying with Section 260529 "Hangers and Supports for Electrical Systems."
- D. Floor-Mounted Central Battery Equipment: Install central battery equipment on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- G. Comply with NECA 1.
- H. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[ and except in accessible ceiling spaces and in gypsum

board partitions where unenclosed wiring method may be used for low-voltage control and alarm wiring]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
  2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
  3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- J. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- L. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect central battery equipment, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
  2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
  3. Test continuity of each circuit.
  4. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.
  5. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
  6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Central battery equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### 3.3 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION 263323.11

## SECTION 263600 - TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes automatic transfer switches rated 600 V and less.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
  - 2. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.
- B. Source quality control reports.
- C. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.



## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 99.
- D. Comply with NFPA 110.
- E. Comply with UL 1008 unless requirements of these Specifications are stricter.
- F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
  - 2. Short-time withstand capability for three cycles.
- H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- K. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- L. Neutral Terminal: Solid and fully rated unless otherwise indicated.
- M. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- N. Battery Charger: For generator starting batteries.

1. Float type, rated 10 A.
  2. Ammeter to display charging current.
  3. Fused ac inputs and dc outputs.
- O. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed shrinkable sleeve markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
  4. Accessible via front access.
- P. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ASCO
  2. Caterpillar, Inc.; Electric Power Division.
  3. Cummins Power Generation.
  4. Generac Power Systems, Inc.
  5. Kohler Power Systems.
- B. Comply with Level 2 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
  2. Switch Action: Double throw; mechanically held in both directions.
  3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
  4. Conductor Connectors: Suitable for use with conductor material and sizes.
  5. Material: Tin-plated aluminum.
  6. Main and Neutral Lugs: Mechanical type.
  7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  8. Ground bar.
  9. Connectors shall be marked for conductor size and type according to UL 1008.

- D. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
  2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
  3. Fully automatic break-before-make operation with center off position.
  4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- F. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.
  2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  5. Test Switch: Simulate normal-source failure.
  6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
  10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
  - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - b. Push-button programming control with digital display of settings.
  - c. Integral battery operation of time switch when normal control power is unavailable.

## 2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- B. Prepare test and inspection reports.
  1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:
    - a. Overvoltage.
    - b. Undervoltage.
    - c. Loss of supply voltage.
    - d. Reduction of supply voltage.
    - e. Alternative supply voltage or frequency is at minimum acceptable values.
    - f. Temperature rise.
    - g. Dielectric voltage-withstand; before and after short-circuit test.
    - h. Overload.
    - i. Contact opening.
    - j. Endurance.
    - k. Short circuit.
    - l. Short-time current capability.
    - m. Receptacle withstand capability.
    - n. Insulating base and supports damage.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
  - 1. Install floor-mounted transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
  - 3. Provide workspace and clearances required by NFPA 70.
- B. Annunciator and Control Panel Mounting: Surface on wall unless otherwise indicated.
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. Comply with NECA 1.

### 3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
  - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.
- F. Final connections to equipment shall be made with liquid tight, flexible metallic conduit no more than 18 inches in length.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual and Mechanical Inspection:

- a. Compare equipment nameplate data with Drawings and Specifications.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and required clearances.
- d. Verify that the unit is clean.
- e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- f. Verify that manual transfer warnings are attached and visible.
- g. Verify tightness of all control connections.
- h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
  - 1) Use of low-resistance ohmmeter.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
- i. Perform manual transfer operation.
- j. Verify positive mechanical interlocking between normal and alternate sources.
- k. Perform visual and mechanical inspection of surge arresters.
- l. Inspect control power transformers.
  - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
  - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
  - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

2. Electrical Tests:

- a. Perform insulation-resistance tests on all control wiring with respect to ground.
- b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
- c. Verify settings and operation of control devices.
- d. Calibrate and set all relays and timers.
- e. Verify phase rotation, phasing, and synchronized operation.
- f. Perform automatic transfer tests.
- g. Verify correct operation and timing of the following functions:
  - 1) Normal source voltage-sensing and frequency-sensing relays.
  - 2) Engine start sequence.

- 3) Time delay on transfer.
  - 4) Alternative source voltage-sensing and frequency-sensing relays.
  - 5) Automatic transfer operation.
  - 6) Interlocks and limit switch function.
  - 7) Time delay and retransfer on normal power restoration.
  - 8) Engine cool-down and shutdown feature.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.
    - d. Perform manual transfer operation.
  4. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
    - a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
    - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    - c. Verify time-delay settings.
    - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
    - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
  5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    - a. Verify grounding connections and locations and ratings of sensors.
- B. Coordinate tests with tests of generator and run them concurrently.
  - C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
  - D. Transfer switches will be considered defective if they do not pass tests and inspections.
  - E. Remove and replace malfunctioning units and retest as specified above.

- F. Prepare test and inspection reports.
- G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
  - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
  - 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

### 3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.

END OF SECTION 263600



## SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

### 2.2 SERVICE ENTRANCE SUPPRESSOR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. General Electric.
  - 3. Square D; by Schneider Electric.
- B. SPDs: Comply with UL 1449, Type 1.
  - 1. SPDs with the following features and accessories:
    - a. Integral disconnect switch.
    - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
    - c. Indicator light display for protection status.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V for 208Y/120 V.
  - 2. Line to Ground: 1200 V for 208Y/120 V V.
  - 3. Line to Line: 1000 V for 208Y/120 V.
- E. SCCR: Equal or exceed 200 kA.
- F. Inominal Rating: 20 kA.

## 2.3 PANEL SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. General Electric.
  - 3. Square D; by Schneider Electric.
- B. SPDs: Comply with UL 1449, Type 2.
  - 1. Include LED indicator lights for power and protection status.
  - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V for 208Y/120 V.
  - 2. Line to Ground: 700 V for 208Y/120 V.
  - 3. Neutral to Ground: 700 V for 208Y/120 V.
  - 4. Line to Line: 1200 V for 208Y/120 V
- E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V.
  - 2. Line to Ground: 700 V.
  - 3. Neutral to Ground: 700 V.
  - 4. Line to Line: 1200 V.
- F. SCCR: Equal or exceed 100 kA.
- G. Inominal Rating: 20 kA.

## 2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 264313

## SECTION 265119 - LED INTERIOR LIGHTING

### 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 the following types of LED luminaires:

1. Downlight.
2. Highbay, linear.
3. Linear industrial.
4. Lowbay.
5. Recessed linear.
6. Strip light.
7. Surface mount, linear.
8. Materials.
9. Finishes.
10. Luminaire support.

- B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.

- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaires.
  - 4. Include emergency lighting units, including batteries and chargers.
  - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
  - 6. Photometric data and adjustment factors based on laboratory tests IES LM-79 and IES LM-80.
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Luminaires.
  - 2. Suspended ceiling components.
  - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
  - 4. Structural members to which equipment and or luminaires will be attached.
  - 5. Initial access modules for acoustical tile, including size and locations.
  - 6. Items penetrating finished ceiling, including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Ceiling-mounted projectors.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Sample warranty.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

## 1.7 QUALITY ASSURANCE

A. Provide luminaires from a single manufacturer for each luminaire type.

B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## 1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Two year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design: The design for each lighting fixture is based on the product named in the drawings. Subject to compliance with requirements, provide either the product named or an approved comparable product by another manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

### 2.3 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
  - 1. ENERGY STAR certified or Design Lighting Consortium Listed.
  - 2. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
  - 3. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
  - 4. UL Listing: Listed for damp location.
  - 5. Recessed luminaires shall comply with NEMA LE 4.
  - 6. User Replaceable Lamps:
    - a. Bulb shape complying with ANSI C78.79.
    - b. Lamp base complying with ANSI C81.61.
- C. CRI of minimum 80. CCT of 3500 K.
- D. Rated lamp life of 50,000 hours to L70.
- E. Lamps dimmable from 100 percent to 1 percent of maximum light output.



F. Internal driver.

G. Nominal Operating Voltage: 120 V ac or 277 V ac.

1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

## 2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Prismatic acrylic unless shown otherwise.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
  - a. "USE ONLY" and include specific lamp type.
  - b. Lamp diameter, shape, size, wattage, and coating.
  - c. CCT and CRI for all luminaires.

## 2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.6 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

### 3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

G. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

- B. Luminaire will be considered defective if it does not pass operation tests and inspections.

- C. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 265119

## SECTION 265213 - EMERGENCY AND EXIT LIGHTING

### 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. Emergency lighting units.
  - 2. Exit signs.
  - 3. Luminaire supports.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
  - 1. Include data on features, accessories, and finishes.
  - 2. Include physical description of the unit and dimensions.

3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
  - a. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
  - b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Luminaires.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
  4. Structural members to which equipment will be attached.
  5. Size and location of initial access modules for acoustical tile.
  6. Items penetrating finished ceiling including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Ceiling-mounted projectors.
    - e. Sprinklers.
    - f. Access panels.
  7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Product Certificates: For each type of luminaire.
- D. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  4. Provide seismic qualification certificate for each piece of equipment.
- E. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample Warranty: For manufacturer's special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

#### 1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

#### 1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two year(s) from date of Substantial Completion.

- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

### 2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
  - 1. See specification section 263323.11 Central Battery Equipment for Emergency Lighting for more information



2. Emergency Connection: Operate one lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Nightlight Connection: Operate lamp in a remote luminaire continuously.
5. Battery: Sealed, maintenance-free, nickel-cadmium type.
6. Charger: Fully automatic, solid-state, constant-current type.
7. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the ballast or emergency power unit manufacturer, whichever is less.
8. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
9. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
10. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
11. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.3 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Luminaires:
  1. Manufacturers: Subject to compliance with requirements, provide products shown on drawings, or approved comparable product from another manufacturer.

## 2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  1. Manufacturers: Subject to compliance with requirements, provide products shown on drawings, or approved comparable product from another manufacturer.

2. Operating at nominal voltage of 120 V ac or 277 V ac.
3. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
6. Master/Remote Sign Configurations:
  - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
  - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

## 2.5 MATERIALS

### A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

### B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

### C. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

## 2.6 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire and emergency power unit weight.
  - 2. Able to maintain luminaire position when testing emergency power unit.
  - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls.
  - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

- B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

### 3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

### 3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
  1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
    - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  2. Conduct short-duration tests on all emergency lighting.
  3. Aim or adjust fixtures.

END OF SECTION 265213

## SECTION 265613 - LIGHTING POLES AND STANDARDS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

#### 1.2 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete lighting fixture.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.
- B. Seismic Qualification Certificates: For poles, accessories, and components, from manufacturer.
- C. Material test reports.
- D. Sample warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data for pole-lowering devices and pole-mounted accessories.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of poles that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Foundation and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. Component Importance Factor: 1.0.
- B. Structural Characteristics: Comply with AASHTO LTS-6-M.
- C. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
- D. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.
- E. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.
- F. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
  - 1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph.
    - a. Wind Importance Factor: 1.0.
    - b. Minimum Design Life: 25 years.
    - c. Velocity Conversion Factor: 1.0.
- G. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.
- H. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.



## 2.2 WOOD POLES

### A. Wood Lighting Standard :

1. Source Limitations: Obtain lighting standards from single manufacturer or producer.
2. Standard Features:
  - a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
  - b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
  - c. General Finish Requirements:
    - 1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
    - 2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
  - d. Douglas fir for wood species used; and bored, roofed, and grained before treatment.
    - 1) Pole Brand: Brand the manufacturer's trademark and date of treatment, height and class of lighting standard, wood species, preservation code, and retention. Brand must be placed so that the bottom of the brand is minimum 10 ft from lighting standard butt.
    - 2) Mounting Provisions: Embedded.
  - e. Preservative Treatment: Treat in accordance with AWWA U1, Use Category UC4A.
  - f. Luminaire Brackets: Comply with NEMA/ANSI C136.13.
3. Other Available Features Required by the Project:
  - a. Fasteners: Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
    - 1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
    - 2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

## 2.3 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

## 2.4 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.
  - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
  - 2. Bent rods.
  - 3. Threading: Uniform National Coarse, Class 2A.
- B. Nuts: ASTM A 563, Grade A, Heavy-Hex
  - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
  - 2. Two nuts provided per anchor bolt.
- C. Washers: ASTM F 436, Type 1.
  - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
  - 2. Two washers provided per anchor bolt.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 POLE FOUNDATION

- A. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on the Drawings, but not less than 6 feet. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
  - 1. Make holes 6 inch in diameter larger than pole diameter.
  - 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days and finish in a dome above finished grade.
  - 3. Use a short piece of 1/2 inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
  - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- B.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole installed below finished grade.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

### 3.2 POLE INSTALLATION

- A. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
- C. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-wide, unpaved gap between the pole or pole foundation and the edge

of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

- D. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

### 3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.
- B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

### 3.4 GROUNDING

- A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

END OF SECTION 265613

## SECTION 265619 - LED EXTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

##### B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

#### 1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale and coordinated.
- B. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of the following:
  1. Luminaire.
  2. Photoelectric relay.
- D. Sample warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
  2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

#### 1.6 FIELD CONDITIONS

- A. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

#### 1.7 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: 2 year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

### 2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.61] or IEC 60061-1.
- F. CRI of minimum 80 CCT of 4100 K unless noted otherwise in drawings.
- G. L70 lamp life of 50,000 hours.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Nominal Operating Voltage: 120 V ac.
- J. In-line Fusing: Separate in-line fuse for each pole mounted luminaire.
- K. Source Limitations: Obtain luminaires from single source from a single manufacturer.

- L. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

## 2.3 LUMINAIRE TYPES

- A. Basis of Design: The design for each lighting fixture is based on the product named in the drawings. Subject to compliance with requirements, provide either the product named or an approved comparable product by another manufacturer.

## 2.4 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- C. Diffusers and Globes:
  - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - 2. Glass: Annealed crystal glass unless otherwise indicated.
  - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- F. Housings:



1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

## 2.5 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
  3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
    - a. Color: As selected by Architect from Manufacturer's standard options.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
  - a. Color: As selected from manufacturer's standard catalog of colors.
  - b. Color: Match Architect's sample of manufacturer's standard color.
  - c. Color: As selected by Architect from manufacturer's full range.

## 2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
  1. Sized and rated for luminaire weight.
  2. Able to maintain luminaire position after cleaning and relamping.
  3. Support luminaires without causing deflection of finished surface.
  4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
  1. Attached to structural members in walls or attached to a minimum **1/8 inch** backing plate attached to wall structural members.
- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- I. Coordinate layout and installation of luminaires with other construction.
- J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

### 3.2 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

- A. Aim as indicated on Drawings.
- B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

### 3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections[ with the assistance of a factory-authorized service representative]:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
    - a. IES LM-5.
    - b. IES LM-50.
    - c. IES LM-52.
    - d. IES LM-64.
    - e. IES LM-72.
  - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

### 3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

END OF SECTION 265619

## SECTION 270010 - COMMUNICATIONS GENERAL PROVISIONS

### 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 DESCRIPTION

##### A. Work Included

- 1. Work shall consist of furnishing all labor, equipment, supplies and materials, unless otherwise specified, necessary for the installation of complete [structured cabling (Voice/Data)][, television][, audiovisual][, and other communications] systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract. The work shall also include the completion of those details of work not mentioned or shown which are necessary for the successful operation of all communications systems.

##### B. Work Not Included

- 1. Certain labor, materials, and equipment may be furnished under other sections of these specifications, by Service Providers or by the Owner; when this is the case, the extent, source, and description of these items will be as indicated on the drawings or as described in the specification.

#### 1.3 PROVISIONS

- A. Work performed under this division of the specifications shall conform to the requirements of Division 1, the technology systems drawings, and all items hereinafter specified.
  - 1. Prior to any work being performed under this division, examine the following drawings and specifications:
    - a. Architectural
    - b. Structural
    - c. Civil
    - d. Mechanical
    - e. Electrical
    - f. Food Service
  - 2. If any discrepancies occur between other drawings and specifications and the technology systems drawings and specifications, report discrepancies to the Architect in writing and obtain written instructions for the work.
  - 3. Technology Systems drawings are diagrammatic, but shall be followed as closely as actual construction of the building will permit. All changes from drawings necessary to make the work conform to the building as constructed shall be made without additional cost to the Owner.
  - 4. Coordinate the communications work with the General Contractor and/or the Electrical Contractor, and be responsible to them for satisfactory progress of the same. Coordinate communications work with all other trades on the project without additional cost to the Owner.
  - 5. All work and materials covered by drawings and specifications shall be subject to review at any time by representatives of the Architect and Owner. If the Architect or Owner's agent finds any materials or installation that does not conform to these drawings and specifications, Contractor shall remove the material from the premises and correct the installation to the satisfaction of the agent.
  - 6. In acceptance or rejection of installed communications systems, no allowance will be made for lack of skill on the part of the installers.

#### 1.4 CODES AND STANDARDS

- A. The latest editions of the following standards (including supplements and official interpretations) are minimum requirements:
1. NFPA 70 - National Electrical Code (NEC)
  2. NFPA 101 – Life Safety Code
  3. Americans with Disabilities Acts (ADA) and American National Standards Institute (ANSI) 117
  4. International Building Code
  5. All applicable State and Local Codes
  6. Underwriter’s Laboratories (UL)
  7. National Electrical Manufacturer’s Association (NEMA)
  8. Insulated Cable Engineers Association (ICEA)
  9. Institute of Electrical and Electronic Engineers (IEEE) standards and publications
  10. Building Industry Consulting Services International (BICSI) publications
  11. Telecommunications Industry Association (ANSI/TIA) standards and publications
- Designer Note:  
Include the following for healthcare related projects.
- B. The complete installation shall comply with requirements of any and all service providers furnishing service to this installation. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent or conflict with the drawings and specifications.

#### 1.5 SPECIAL REQUIREMENTS

- A. Definitions: “Provide” shall mean “furnish and install”. “Furnish” means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application. “Install” means to join, unit, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation. The words “accept” or “acceptable” denote only that the equipment items are in general conformance with the design concept of the project.
- B. Drawings:
1. The drawings indicate the general arrangement and location of outlets, devices, main/intermediate distribution frames, major pathways, and other work. Information shown on the drawings is schematic. Drawings and specifications are complementary to each other. What is called for by one shall be as binding as if called for by both. Data presented on these drawings is accurate as planning can be determined, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all Architectural, Structural, Mechanical and Electrical Drawings and Specifications; adjust all work to conform to all conditions shown therein. The Architectural drawings shall take precedence over all other drawings.
  2. Discrepancies between different plans, between plans and specifications, between specifications or regulations and codes governing this installation shall be brought to the attention of the Architect in writing before the date of bid opening. In the event such discrepancies exist, and the Architect is not so notified, the adjudication of responsibility shall be solely at the discretion of the Architect.

#### 1.6 EXAMINATION OF BIDDING DOCUMENTS

- A. Each bidder shall examine the bidding documents carefully, and not later than seven days prior to the date of receipt of bids, shall make written request to the Engineer for interpretation or correction of any discrepancies, ambiguity, inconsistency, or error therein which he may discover. Any interpretation or correction will be issued as an addendum by the Architect. Only a written interpretation or correction by addendum shall be binding. No bidder shall rely upon interpretations or corrections given by any other

method. If discrepancies, ambiguity, inconsistency, or error are not covered by addendum or written directive, Contractor shall include in his bid, labor materials and methods of construction resulting in higher cost. After award of contract, no allowance or extra compensation will be made on behalf of the Contractor due to his failure to make the written requests as described above.

- B. Failure to request clarification during the bid period of any inadequacy, omission, or conflict will not relieve the Contractor of their responsibilities. The signing of the contract will be considered as implicitly denoting that the Contractor has a thorough comprehension of the full intent and scope of the working drawings and specifications.

#### 1.7 PERMITS, FEES & NOTICES

- A. Obtain and pay for all necessary permits, inspections and certificates that may be necessary for the full completion of the work. Furnish the [Architect] [Owner] with a certificate of final inspection and approval from the AHJ over the electrical installation.
- B. Notify proper authorities when work is ready for inspections required by applicable codes, rules and regulations, allowing sufficient time for inspections to be made without hindering progress of the work. Furnish to the Owner copies of inspection certificates of acceptance.

#### 1.8 TESTS

- A. Upon completion of all work and adjustment of all equipment, provide complete operational tests of all communications systems provided under this division.

#### 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of BICSI RCDD or BICSI ITS Installer 2.
  - 2. Installation: Installation shall be performed by a minimum BICSI ITS Installer 1.
  - 3. Installation Supervision: Installation shall be under the direct supervision of BICSI ITS Installer 2, who shall be present at all times when Work of this Section is performed at Project site.

#### 1.10 WARRANTY

- A. Guarantee that all work governed by this division shall be free of defects in workmanship, materials and parts for a minimum period of one (1) year after written acceptance, unless otherwise noted. Promptly repair, revise, and replace defects as directed with no additional cost to the Owner.
- B. Where specific lists of structured cabling manufacturers are listed, Contractor shall provide manufacturers such that extended warranties, at a minimum period of fifteen (15) years after installation, available for complete systems are provided.
- C. Where extended warranties are to be provided, Contractor shall be fully certified by applicable manufacturer for install as to provide such extended warranty.

#### 1.11 SUBMITTALS

- A. Submit under provision of Division 1.
- B. Action Submittals:
  - 1. Product Data: For each type of product indicated.
    - a. Listing of Equipment: The Contractor shall provide a complete typewritten list of those items of equipment which will be furnished under each Section. Include the name or description of the item, name of manufacturer, model, type, and catalog number.
    - b. Product Data Sheets ("Cutsheets"): The contractor shall provide a manufacturer-published product data sheet for all products requiring product data submittals. Reference other Division 27 sections for required products. Product data sheets shall be formatted as follows:

- 1) Manufacturer-published PDF, indicating appropriate makes, models, operating characteristics, physical characteristics, finishes/colors, etc.
  - 2) Product intended to be used shall be clearly highlighted, unless clear and obvious from product data sheet provided
  - 3) For products that are scheduled in the Drawings, the product data sheet shall contain at the upper right corner the following information:
    - a) Project name or title
    - b) Equipment tag per scheduled equipment in the Drawings
    - c) Full model number intended to be used unless clear and obvious from product data sheet provided
  - 4) Printed websites or operations manuals are not acceptable alternates to manufacturer-published data sheets.
- c. Product Data Submittal Packages: Product data shall be submitted as follows:
- 1) Submitted in PDF format
  - 2) One (1) submittal package per Specification Section; correct corresponding specification section number and name shall be indicated
  - 3) Listing of Equipment shall serve as table of contents for product data submittal package
  - 4) PDF shall contain bookmarks and clickable links between products indicated in Listing of Equipment and corresponding product data sheet
- d. Product data submittal packages that do not comply with these requirements, or requirements indicated elsewhere in this Specification, will be rejected without review.
2. Shop Drawings: For communications systems. Include floor plans, site plans, elevations, sections, functionals, details, and attachments to other work.
- a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Informational Submittals:
1. Qualification Data: For installer and installation supervisor.
- D. Closeout Submittals:
1. Warranty Information: Active manufacturer and Contractor's warranty, including contact information for each, and documentation supporting extended warranties.
  2. Product Data: Product data of all components submitted for review under Product Data submittal requirements, subject to requirements of that section.
  3. Operating Manuals: Operations manual for all components submitted for review under Product Data submittal requirements, as applicable. Manuals shall be bookmarked in PDF format.
  4. Test results: Completed test results as required in this Specification and on the Drawings.
  5. Cable Administration Drawings.
  6. Project as-builts.
- E. Submittals will be reviewed as follows:
1. REV (Reviewed): Information provided is acceptable as submitted. Additional direction may be provided. If revised submittals are expected, inclusion in subsequent submittals will not be reviewed.
  2. FAC (Furnish As Corrected): Information provided is acceptable upon accommodation of minor comments provided.
  3. R&R (Revise and Resubmit): Information provided is insufficient. Resubmit accommodating comments provided.
  4. REJ (Rejected): Information provided is unacceptable. Review requirements and resubmit.
  5. NR (Not Reviewed): Information provided has not been specifically reviewed per comments provided.



- F. Do not begin work until applicable submittal reviews are fully resolved and returned.
- G. Submit any additional information as may be requested by the Architect for their review. The review by the Architect will not constitute concurrence with any deviation from the plans and specifications unless such deviations are specifically identified by the method described below, nor shall it relieve the Contractor of responsibility for errors or omissions in the submitted data.
- H. Processed submittals shall not be construed as change orders. The shop drawings shall demonstrate that the Contractor understands the design concept, indicate which equipment and materials the Contractor intends to provide, and detail the fabrication and installation methods the Contractor intends to use. If deviations, discrepancies or conflicts between submittals and the design drawings and specifications are discovered, the design drawings and specifications shall govern.
- I. Product data submittals shall not be used for Contractor-initiated substitutions. Product data submitted that does not align with specifications will be rejected.
- J. Contractor shall be responsible for dimensions (which shall confirm and correlate at the job site), fabrication processes and techniques of construction and coordination of their work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them and sign a statement on the shop drawings which signifies that they comply with plans and specifications and that equipment is dimensionally suitable for the application. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal. The Owner's copies of the reviewed submittals shall be retained by the Contractor until completion of the project and presented in bound form to the Owner.

#### 1.12 RECORD DRAWINGS

- A. Maintain a current set of communications drawings at the site. Neatly mark all changes and deviations from the original drawings. Use a color which contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses and shall be made available for inspection by the Architect and Engineer at all times. These updated progress drawings shall be used to produce the final record drawings that shall be in AutoCAD electronic format media upon project completion.
- B. Upon completion of the contract, both sets (electronic and hard copy drawings) of record drawings shall be delivered to the Architect.
- C. The Contractor shall mark all record drawings on the front lower right hand corner with a stamp impression that reads 'RECORD DRAWINGS' or similar.

#### 1.13 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prior to submitting a bid, visit the site of job and ascertain all conditions affecting the proposed installation and adjust all work accordingly. Make provisions for these costs.
- C. Coordinate the work with that of all other trades. Where conflicts of work occur and departure from the indicated arrangements are necessary, consult with other Contractors involved; come to agreement as to changed locations and elevations, etc., and obtain written acceptance from the Architect of proposed changes before proceeding with work.
- D. All outages of pre-established telecommunications service shall be scheduled with the Owner and Service Provider five (5) days in advance of proposed outage. Include an overtime allowance in the bid for the performance of all work requiring outages at such time as it is approved by the Owner. Outages shall be at a time and of such duration as accepted by the Owner.

#### 1.14 SEQUENCING AND SCHEDULING

- A. Construct Work in sequence under provisions of Division 1.

#### 1.15 USE OF THE ARCHITECT'S AND/OR ENGINEER'S DRAWINGS

- A. The Contractor shall obtain, at the Contractor's expense, from the Architect or Engineer a set of AutoCAD or compatible format architectural and engineering drawings on electronic media where desired by the Contractor and/or required by the Specifications for use in preparing the shop drawings, coordination drawings, and record drawings. The Contractor shall provide to the Architect and Engineer a written release of liability acceptable to the Architect and Engineer prior to receiving the electronic media.

### PART 2 - PRODUCTS

#### 2.1 STANDARD FOR MATERIALS

- A. All materials shall conform to current applicable industry standards. Workmanship and neat appearance shall be as important as the system operation. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Architect, Engineer or Owner at no additional cost to the Owner.
- B. All materials shall be acceptable for installation only if labeled or listed by a nationally recognized testing laboratory and if accepted by local authorities.
- C. All materials shall be acceptable for installation only if in compliance with requirements set forth in this specification.

#### 2.2 BID ALTERNATE(S)

- A. Refer to Division 1 and all contract documents for additional information.
- B. Alternate(s) for Material and Equipment
  - 1. Equipment and material bid alternate(s) shall be proposed as additive or deductive alternate(s) to specified items by submitting it as a separate line item from the base bid on the Bidder's letterhead.
  - 2. Such bid alternate proposals shall not be substituted or included in the base bid. Bid alternate proposal(s) must be accompanied by full descriptive data on the proposed equipment, together with a statement of the cost to be added or deducted for each item. The bid alternate shall include all materials, equipment, labor, connections, coordination with all other trades, etc. for a complete and operational system.
  - 3. The Contractor shall submit the bid alternates at the time the base bids are due.

#### 2.3 SUBSTITUTION AND APPROVALS (PRIOR APPROVALS)

- A. Prior to Bidding: Where items of equipment or materials are specified by a manufacturer's name, type, model, or catalog number, only those items may be used in the base bid unless prior written acceptance of other material has been published by addendum.
  - 1. Submit applications for this review in triplicate at least ten (10) calendar days prior to bid opening.
  - 2. Applications for review shall be accompanied by a typewritten list of the specified manufacturer and catalog number and shall state all significant details in which each item differs from the item specified. Failure to list this information shall not relieve the Contractor from providing properly functioning or fitting materials regardless of the review action taken by the Architect. The Contractor will provide only materials which have been specified or accepted prior to bid opening, under his base bid.
  - 3. Equipment and materials not listed as equivalents may be proposed as deductive alternates to specified items by submitting it as a separate line item from the base bid on the Bidder's letterhead.

4. Such substitution proposals shall not be substituted or included in the base bid. Substitution proposal must be accompanied by full descriptive data on the proposed equipment, together with a statement of the cost to be deducted for each item. If any such substitutions are considered, the Contractor shall submit a list of the proposed substitution items within 14 days of award of contract. The request for proposed substitutions shall not be accepted by the Engineer due to scheduling or delivery concerns.

B. Substitutions of Material after Award of Contract

1. Other items of material and equipment may be offered (at the Contractor's option) as alternates to specified items, either as provided for in the Proposal Forms or, if no provisions are made, by submitting it with his bid on the Bidder's letterhead.
2. Such alternate proposal shall not be included under the base bid and must be accompanied by full descriptive data on the proposed equipment, together with a statement of the cost to be added or deducted for each item. If any such alternate material proposals are considered, the Contractor shall submit a list of the proposed alternate substitution items in accordance with the requirements of "Review of Proposed Substitutions".

2.4 SUBSTITUTIONS (CONTRACTOR AND/OR OWNER INITIATED)

- A. Materials or equipment listed by several manufacturers' names are intended to be bidder's choice, and any of the listed manufacturers may be used in the base bid. Materials or equipment not listed are considered substitutions.
- B. Performance Specification: When any item is specified by requirement to meet a performance, industry or regulating body standard or is specified generically (no manufacturer's name listed), no prior review by the Engineer is needed unless specifically called for in these specifications.
- C. Contractor to be responsible for any changes and costs to accommodate any equipment except that identified as a basis-of-design.
- D. Substitutions for Material and Products
  1. The base bid shall accommodate materials and products as specified. Bids found to be based on substitutions that have not been accepted at time of bid will have substitutions rejected, and Contractor will be required to provide material and products as specified at the cost of the bid.
  2. Substitution Requests:
    - a. Equipment and materials not listed as equivalents may be proposed as deductive alternates to specified items by submitting it as a separate line item to the base bid on the Bidder's letterhead.
    - b. Substitution requests shall provide:
      - 1) Reason for substitution request
      - 2) A full description of the difference between the Contract Document requirements and that of the substitution
      - 3) Effect of the change on the resulting performance
      - 4) Impact of all changes on other contractors and acknowledge the inclusion of additional costs to the other trades
    - c. The Contractor shall submit substitution requests within 30 days of award of contract. Late requests for proposed substitutions will not be accepted by the Engineer due to scheduling or delivery concerns.
  3. Substitution requests shall be separate from and resolved prior to Engineer's review of product data submittal packages.
  4. Products or materials requiring substitution due to end-of-life or obsolescence shall be subject to substitution request process.

5. Products substituted by the Contractor without following the identified protocol will not be reviewed.

## PART 3 - EXECUTION

### 3.1 WORKMANSHIP AND COMPLETION OF INSTALLATION

- A. Contractor's personnel and subcontractors selected to perform the work shall be well versed and skilled in the trades involved.
- B. Coordinate equipment and materials installation with other building components.
- C. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring specific positioning.
- D. Any changes or deviations from the drawings and specifications must be accepted in writing by the Architect/Engineer. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where detail or specific installation requirements are not provided, manufacturer's recommendations shall be followed.
- E. Upon completion of work, all equipment and materials shall be installed complete, thoroughly checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residue shall be removed from surfaces. Exterior surfaces of all material and equipment shall be delivered in a perfect, unblemished condition.
- F. Contractor shall provide a complete installation, including all required labor, material, cartage, insurance, permits, and taxes.

### 3.2 PROGRESS OF WORK

- A. Order the progress of communications work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit. Any cost resulting from defective or ill-timed work performed under this Section shall be borne by this Contractor.

### 3.3 DELIVERY AND STORAGE OF MATERIALS

- A. Arrange and be held responsible for delivery and safe storage of materials and equipment for installation.
- B. Store materials and equipment for easy inspection and checking.
- C. Carefully mark and store all materials.
- D. Deliver materials to the job site in stages of the work that will expedite the work as a whole.
- E. Carefully check materials furnished to this Contractor for installation, and provide receipt acknowledging acceptance of delivery and condition of the materials received. Thereafter, assume full responsibility for its safekeeping until the final installation has been reviewed and accepted.

### 3.4 TRENCHING AND BACKFILLING

- A. Perform all trenching and backfilling required by work performed under this Section in accordance with the excavating and grading specifications as herein specified. This work shall comply with the requirements of Table 300-5 of the National Electrical Code.
- B. Excavate trenches to the depth required for the utilities involved. The trench bottom shall be graded true and free from stones or soft spots. Trenches through specially treated or surfaced areas, such as paving or blacktop, shall have the width of the surface cutting extended for a width of eight inches (8") on each side of the open trench. Unless otherwise noted, the disturbed surfaces shall be replaced equal to the original construction, to the original grade with the same type of material, and to the same depths and limits as the materials removed. After acceptance by the Architect, backfill, tamp, and compact to insure against the possibility of differential settling, in conformity with Division 2 Specifications. Verify location of existing or new utilities and, if damaged by this Contractor, replace or repair.

### 3.5 CHASES, OPENINGS, CUTTING, AND PATCHING

- A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the Architect. Any necessary cutting, channeling, drilling or anchoring of raceways, outlets, or other equipment shall be performed in a careful manner, and as accepted by the Architect.
- B. All openings made in fire-rated walls, floors, or ceilings shall be patched and made tight in a manner to conform to the fire rating for the surface penetrated.
- C. All penetrations required through existing concrete construction shall be core drilled at minimum size required. Precautions shall be taken when drilling to prevent damage to structural concrete. Contractor shall obtain permission from the Architect before proceeding with drilling.
- D. Provide all cutting, trenching, backfilling, patching and refinishing or resurfacing required for electrical work in a manner meeting the approval of the Engineer and at no additional cost to the Owner.

### 3.6 PROTECTION OF WORK AND PROPERTY

- A. Where there are existing facilities, be responsible for the protection thereof, whether or not such facility is to be removed or relocated. Moving or removing any facility must be done so as not to cause interruption of the work of Owner's operation.
- B. Close all conduit openings with caps or plugs during installation. Cover all fixtures and equipment and protect against injury. At the final completion, clean all work and deliver in an unblemished condition, or refinish and repaint at the discretion of the Architect.
- C. Any equipment or conduit systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Engineer's satisfaction.

### 3.7 FINAL ACCEPTANCE

- A. Final acceptance by the Owner will not occur until all operating instructions are received, all necessary tests have been demonstrated as "PASS", and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment.
- B. Operating manual, parts lists, and indoctrination of operating and maintenance personnel: Furnish the services of a qualified representative of the supplier for each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.
- C. Instruction shall be made when the particular system is complete and shall be of the number of hours and at the time requested by the Owner. A representative of the Electrical Contractor shall be present for all demonstrations.
- D. Deliver three (3) complete operating manuals and parts lists to the Owner (or his designated representative) at the time of the above required indoctrination. Fully explain the contents of the manuals as part of required indoctrination and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period. The operating manual and parts lists shall give complete information as to whom the Owner shall contact for service and parts, including the address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within twenty four (24) hours after requested.
- E. Clean up: Remove all materials, scrap, etc., relative to the communications installation and leave the premises and all equipment, outlets, patchpanels, etc. in a clean, orderly condition. Any costs to the Owner for clean up of the site will be charged against the Contractor.

### 3.8 ELECTRICAL PROVISIONS FOR ROOFS

- A. Raceways penetrating roofs shall be installed in a manner to preserve the integrity of the roof. Provide flashing and counter flashing for all roof penetrations required for the work.
- B. Conduits routed above roofs shall be installed a minimum of twelve inches (12") above the finished roof surface, supported on metal stands installed with flashing and counter flashing, with maximum spacing of ten feet (10'-0").
- C. Raceways penetrating roofs shall be terminated in weatherhead or weatherproof junction box.

### 3.9 ELEVATORS

- A. Locate equipment and points of connection in elevator machine rooms, elevator pits, or at shaft-installed elevator machinery in accordance with the requirements of the elevator vendor and the Authority Having Jurisdiction.
- B. Provide a dedicated telephone connection for each elevator for cab voice communications. Homerun to nearest serving distribution frame.
- C. Provide a dedicated network connection for each elevator for cab video communications. Homerun to nearest serving distribution frame.

### 3.10 KITCHEN EQUIPMENT

- A. For all kitchen equipment provided under other divisions of these specifications, provide cabling and outlets for equipment in accordance with the manufacturer's shop drawings and recommendations.  
Where equipment in open areas is served from under floor wiring, terminate conduit in a flush coupling at the floor or suitable watertight box, from which point extend a rigid conduit nipple at least eight inches (8") above the floor. Provide flexible conduit connections to the equipment. Make all conduit connections at the floor watertight.
- B. Data connections shall be provided for required food service equipment, including (but not limited to):
  - 1. Point-of-Sale (PoS) terminals
  - 2. PoS printers
  - 3. Kitchen line printers
  - 4. PoS headends
- C. Data connections for food service equipment shall comply with specification section "Communications Horizontal Cabling".

### 3.11 OWNER PROVIDED EQUIPMENT

- A. Provide required communications connections to Owner-furnished equipment.
- B. Inspect owner furnished equipment for damage, defects, missing components, etc. Report deficiencies to the Owner immediately. Do not install or connect deficient equipment.
- C. Provide supports, fastenings, and auxiliary hardware necessary for a complete installation in accordance with the finished building conditions.

END OF SECTION 270010

### 3.5 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections[ with the assistance of a factory-authorized service representative]:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
    - a. IES LM-5.
    - b. IES LM-50.
    - c. IES LM-52.
    - d. IES LM-64.
    - e. IES LM-72.
  - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

### 3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

END OF SECTION 265619

## SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

### 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. Bonding conductors.
  - 2. Bonding connectors.
  - 3. Bonding busbars.

#### 1.3 DEFINITIONS

- A. TBC: Telecommunications bonding conductor.
- B. PBB: Primary bonding busbar.

#### 1.4 ACTION SUBMITTALS

- A. Reference Section 271000, "General Communications Provisions" for additional submittal requirements.
- B. Product Data: For each type of product.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Reference Section 271000, "General Communications Provisions" for additional submittal requirements.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For applicable connectors.
- B. Test Results.
- C. Warranty: Documentation of proof of warranty for products and systems installed.
- D. As-Builts: CAD/DWG and hardcopy format of project as-builts, indicating locations, routing, quantities, and other pertinent information for final conditions.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

- A. 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.
- C. Comply with TIA-607-C.
- D. RoHS Compliant.

#### 2.2 CONDUCTORS

- A. Comply with UL 486A-486B.
- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
  - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
  - 2. Cable Tray Equipment Bonding Wire: No. 6 AWG.



C. Cable Tray Bonding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped bonding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with bonding screw or connector provided by cable tray manufacturer.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

## 2.3 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
  1. Electroplated tinned copper, C and H shaped.
- C. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection compatible with the used busbar.
- D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.4 BONDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Chatsworth Products, Inc.
  2. Hubbell Premise Wiring.
  3. nVent ERICO.
  4. Panduit.
- B. Primary Bonding Busbar (PBB): Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, 12" length or as indicated on Drawings.
  1. Predrilling shall be with holes for use with lugs specified in this Section.
  2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
  3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. Rack and Cabinet Bonding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG.
  1. Predrilling shall be with holes for use with lugs specified in this Section.
  2. Rack-Mounted Horizontal Busbar: Designed for mounting to specified equipment racks. Brackets and bolts shall be stainless steel.
  3. Rack-mounted Vertical Busbar: Designed for mounting to specified equipment racks, 36-inch length or as indicated on Drawings. Brackets and bolts shall be stainless steel.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the AC grounding electrode system and equipment bonding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the AC grounding system measured at the point of TBC connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the TBC only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Bonding shall include the AC utility power service entrance, the communications cable entrance, and the building grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-C.

### 3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
  - 1. The bonding conductors between the SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
  - 2. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Conductor Terminations and Connections:
  - 1. Busbar Connections: Bolted, compression style connectors.
  - 2. Pipe and Equipment Bonding Conductor Terminations: Bolted connectors.
  - 3. Connections to Structural Steel: Welded connectors.
- C. Conductor Support:
  - 1. Secure grounding and bonding conductors at intervals of not less than 60 inches (900 mm).
- D. Bonding Conductors:
  - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
  - 2. Install without splices.
  - 3. Support at not more than 60-inch (900-mm) intervals.
  - 4. Install grounding and bonding conductors using specified communications pathways until pathway enters a telecommunications room.
    - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a SBB.

### 3.4 BONDING ELECTRODE SYSTEM

- A. The TBC between the PBB and the AC service equipment ground shall be #2/0 AWG unless otherwise dictated on the Drawings.

### 3.5 BONDING BUSBARS

- A. Intended locations of bonding busbars shown on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 24 inches (600 mm) above finished floor unless otherwise indicated.

### 3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the bonding busbar in that room, using equipment bonding conductors not smaller than #6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
  - 1. Use crimping tool and the die specific to the connector.
  - 2. Pretwist the conductor.
  - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Circuit Protector: Bond to the PBB with insulated bonding conductor.
- E. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install a top-mounted or vertically mounted rack bonding busbar where indicated, unless the enclosure and rack are manufactured with the busbar. Bond the equipment bonding busbar to the SBB using No. 2 AWG bonding conductors.
- F. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.
- G. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panelboard.
- H. Shielded Cable: Bond the shield of shielded cable to the rack-mounted bonding busbar or SBB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when bonding shielded balanced twisted-pair cables.
- I. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack bonding bar. Power connection shall comply with NFPA 70; the equipment bonding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections; engage a qualified third-party testing agency if necessary.
- B. Tests and Inspections:
  - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and a SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
    - a. Measure the resistance between the busbar and the nearest available bonding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
  - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
    - a. With the bonding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB. Maximum acceptable AC current level is 1 A.

- C. Excessive Ground Resistance: If resistance to ground at the TBC exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Bonding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 270526

## SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

### 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. Metal conduits and fittings.
  - 2. Nonmetallic conduits and fittings.
  - 3. Optical-fiber-cable pathways and fittings.
  - 4. Surface pathways.
  - 5. Individual multi-cable hangers.
  - 6. Boxes, enclosures, and cabinets.
  - 7. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
  - 1. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

#### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, hinged-cover enclosures, and cabinets.

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUITS AND FITTINGS

- A. General Requirements for Metal Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. ARC: Comply with ANSI C80.5 and UL 6A.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - a. Material: Steel or die cast.
    - b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
  4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- H. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Comply with TIA-569-B.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Continuous HDPE: Comply with UL 651B.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

## 2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Carlon.
- B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Comply with TIA-569-B.

## 2.4 INDIVIDUAL MULTI-CABLE HANGERS

- A. Description: Individually mounted re-closeable hangers, metallic or synthetic material, capable of supporting cables as necessary.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
1. Comply with TIA-569-B.
  2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Gangable boxes are prohibited.
- F. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- G. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

## 2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

- A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  1. Standard: Comply with SCTE 77.
  2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  5. Cover Legend: Molded lettering, "COMMUNICATIONS".
  6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  7. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

### PART 3 - EXECUTION

#### 3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
  1. Exposed Conduit: GRC.
  2. Concealed Conduit, Aboveground: EMT.
  3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
  4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
  1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed, Not Subject to Severe Physical Damage: EMT.
  3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Pathways located above accessible ceilings: Multi-cable hangers.
  6. Damp or Wet Locations: GRC.
  7. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
  8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 nonmetallic in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 1 inch (27 mm).
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
  1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

### 3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Pathways above accessible ceilings:
  - 1. Locate multi-cable hangers as required. Field-coordinate cable routing. Cabling shall be supported at 5'-0" or less intervals.
  - 2. Attach hangers to structure. Use appropriate metallic suspension rods, concrete or steel fasteners, etc.
  - 3. Arrange hangers and route cabling such that cabling does not contact with anything else, such as structure, MEP systems, and the like.
- J. Pathways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
  - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange pathways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- K. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT for pathways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.



- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
  - 1. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
  - 2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service pathway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- W. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).  
Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
  - Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
  - Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
  - AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
  - BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
  - CC. Set metal floor boxes level and flush with finished floor surface.
  - DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

### 3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND  
CABLING

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. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Silicone sealants.
- B. Related Requirements:
  - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
  - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Carbon steel.
  - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed[ or unless seismic criteria require different clearance].
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.  
END OF SECTION

## SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

### 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. Telecommunications mounting elements.
  - 2. Backboards.
  - 3. Telecommunications equipment racks and cabinets.
  - 4. Cable runway.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: See Section 271000 - Communications General Provisions.

### PART 2 - PRODUCTS

#### 2.1 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, AC-grade. Comply with requirements for plywood backing panels specified in Section 061000 - Rough Carpentry.

#### 2.2 EQUIPMENT FRAMES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Chatsworth Products, Inc.
  - 2. Cooper / B-Line.
  - 3. Legrand / Ortronics, Inc.
- B. General Frame Requirements:
  - 1. Distribution Frames: Freestanding and/or wall-mounting, modular steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
  - 2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
  - 3. Finish: Manufacturer's standard, baked-polyester powder coat, black finish.
- C. Two-Post Floor-Mounted Racks: Modular-type, aluminum construction; 1000lb capacity.
  - 1. 45RU (7'-0"H).
  - 2. #12-24 tapped threaded holes both sides of vertical channels.
  - 3. Top angle configuration.

4. Vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
- D. Wall-Mounted Cabinets: Modular type, steel construction.
  1. 2RU unless otherwise noted.
  2. Dimension: 26"W x 26"H.
  3. Acceptable Product: Chatsworth Products, Inc. ThinLine II, or approved equal.
- E. Rack-Mounted Cable Management:
  1. Basis of Design Product: Subject to compliance with requirements, provide Chatsworth Products, Inc. Evolution series, or approved equal.
  2. Thermoplastic, with T-shaped integral cable guides.
  3. Vertical and horizontal cable management styles shall match.
  4. Vertical cable management:
    - a. Front and rear channels, each with latchable, two-way hinged covers.
    - b. 8" Width, full-height.
    - c. Black finish.
  5. Horizontal cable management:
    - a. Single-sided with snap-on cover.
    - b. 2RU height, full-width unless noted otherwise.
    - c. Black finish.
  6. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

## 2.3 CABLE RUNWAY

- A. Basis of Design Product: Subject to compliance with requirements, provide products by Chatsworth Products, Inc, or comparable.
- B. Cable Runway:
  1. 3/8 inches by 1-1/2 inches by 0.065" thick rectangular steel tubing.
  2. Cross-members at 12" rung spacing.
  3. 12 inches][18 inches][24inches] wide by 10'-0" segments, field-modified to fit field conditions.
  4. Black powder-coated finish.
- C. Runway Accessories:
  1. Cable Runway radius drop at all vertical cable managers.
  2. Butt-splice kits at all on-axis connections of runway.
  3. Junction splice kits at perpendicular connections of runway.
  4. Corner brackets at perpendicular connections of runway.
  5. Cable Runway Elevation Kit (3") at all racks, frames and cabinets.
  6. Steel triangular support bracket at 5'-0" on center for wall-mounted runway.
  7. Wall angle support kit at perpendicular connections between wall and runway.
  8. Foot kit at vertical runway connection to floor.
  9. Vertical wall brackets for vertical runway.
  10. Runway support brackets for suspended runway.
  11. Protective end caps for all exposed runway ends.
  12. All accessories with finish options shall be black powder-coated finish.

## 2.4 POWER STRIPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Chatsworth Products, Inc.
  2. Server Technologies.



3. Geist.
- B. Vertical Power Strips: Comply with UL 1363.
  1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Vertical rack mounting.
  3. 20A, 120V Input.
  4. 24, 20A, 120V, NEMA 5-20R receptacles.
  5. LED indicator lights for power and protection status.
  6. 20A Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
  7. Cord connected with 10-foot line cord with NEMA L5-20P locking plug.
  8. Integral surge protection; 330V, 1100 Joules.

## 2.5 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Comply with requirements in Section 27 0528 "Pathways for Communications Systems" for materials and installation requirements for direct-buried pathways.

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of entrance facilities, communications equipment rooms and telecommunications rooms.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for cable management.
- D. Coordinate layout and installation of communications equipment with Owner's telecommunications and networking staff. Coordinate service entrance arrangement with Owner's preferred local exchange carrier.
  1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
  2. Record agreements reached in meetings and distribute them to other participants.
  3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
  4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

### 3.3 BACKBOARDS

- A. Install backboards vertically, bottom at +6" AFF. Butt backboard sheets together tightly.

- B. Install backboards with 'A' grade side of plywood facing into room.

#### 3.4 RACKS, CABINETS AND FRAMES

- A. Install per Manufacturer's recommendations.
- B. Bolt telecommunications racks, cabinets and frames securely to floor.
- C. Where multiple racks, cabinets or frames exist in a row, install such that front face of mounting elements are aligned.

#### 3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 - Penetration Firestopping.
- B. Comply with TIA-569-B, Annex A, "Firestopping".
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

#### 3.6 GROUNDING & BONDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-C.
- C. Locate busbars to minimize the length of bonding conductors. Mount busbars at 24 inches above floor.
- D. Bond metallic equipment to the busbar.
  - 1. Bond the shield of shielded cable to the busbar in communications rooms and spaces.
  - 2. All metallic frames and supporting components shall be bonded together.

#### 3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
- B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

END OF SECTION

## SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

### 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. Singlemode optical fiber backbone cable.
  - 2. Cable connecting hardware, patch panels, and cross-connects.
  - 3. Cabling system identification products.

#### 1.3 ADMINISTRATIVE AND COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner and Owner's authorized agents.
- B. Coordinate location of power connections, mechanical equipment, and lighting fixtures in telecommunications rooms.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Comply with Section 270010 "Communications General Provisions."

#### 1.5 WARRANTY

- A. Comply with Section 270010 "Communications General Provisions."

#### 1.6 ACTION SUBMITTALS

- A. Reference Section 270010, "Communications General Provisions" for additional submittal requirements.
- B. Product Data: For each type of product.
- C. Shop Drawings:
  - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
  - 2. Cabling administration drawings and printouts.
  - 3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Reference Section 270010, "Communications General Provisions" for additional submittal requirements.

#### 1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Test Results: For every cable installed.
- C. Warranty: Documentation of proof of warranty, including extended warranties, for products and systems installed.
- D. As-Builts: CAD/DWG and hardcopy format of project as-builts, indicating locations, routing, quantities, and other pertinent information for final conditions.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.

1. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each.  
Retain test data and include the record in maintenance data.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1 when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with TIA-607-C.
- E. RoHS Compliant.

### 2.2 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Belden
  2. Berk-Tek
  3. CommScope
  4. Corning
  5. Hitachi
- B. Optical Fiber Description: Multi-fiber, tight buffer, optical fiber cable.
  1. Comply with ICEA S-83-596 for mechanical properties.
  2. Comply with TIA-568-C.3 for performance specifications.
  3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
    - a. General Purpose, Nonconductive: Type OFN or OFNG.
    - b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    - c. Indoor/Outdoor Rated, Nonconductive.
- C. Multimode Optical Fiber Characteristics:
  1. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
  2. Category Specifications:
    - a. Category OM4 (50/125-micron, "laser-optimized")
      - 1) Minimum Modal Bandwidth: 3500 MHz\*km at 850nm, 4700 MHz\*km at 1300nm.
      - 2) Supports 1Gbps to 1000 meters (1000BASE-SX).
      - 3) Supports 10Gbps to 550 meters (1000BASE-SR).
      - 4) Supports 40Gbps to 150 meters.
      - 5) Supports 100Gbps to 150 meters.
  3. Jacket:
    - a. Jacket Color: Aqua for 50/125-micrometer cable.
    - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
    - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- D. Singlemode Optical Fiber Characteristics:

1. Configuration: 9/125-micron.
2. Category Specifications:
  - a. Category OS2:
    - 1) Maximum Attenuation: 0.4 dB/km at 1300nm and 1550nm.
3. Jacket:
  - a. Jacket Color: Yellow.
  - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
  - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

## 2.3 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Belden
  2. CommScope
  3. Corning
  4. Leviton
  5. Ortronics
- B. Patchpanels: Modular enclosures housing multiple numbered cable connectors, with hinged cover.
  1. Cable Termination: Pass-through bulkhead.
  2. Enclosure Mounting: Rack-mounted.
  3. Number of Connectors per Field: One for each fiber assigned to field, plus 25 percent spare positions, not to exceed the minimum number of required patchpanels.
- C. Cable Connecting Hardware:
  1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA-604-12. Comply with TIA-568-C.3.
  2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.

## 2.4 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-C and NECA/BICSI-607.

## 2.5 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation points provided by communications service providers.

### 3.2 WIRING METHODS

- A. Free-Wiring Installation: Install cables above ceilings and within partitions without pathways.
- B. Accessible areas: Install cables using Arlington loops, J-hooks or cable trays.
  1. Arlington loops and J-hooks shall be spaced no greater than 60 inches on center.
  2. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
  3. Install plenum cable in spaces used to convey environmental air.

- C. Inaccessible areas: Install cables using conduits and conduit sleeves.
    - 1. Comply with requirements in Section 270528 "Pathways for Communications Systems."
    - 2. Install plenum cable in environmental air spaces, including plenum ceilings.
  - D. Conceal cables where possible. Install cabling in a neat and orderly fashion where visible.
  - E. Comply with NECA 1.
  - F. General Requirements for Cabling:
    - 1. Comply with TIA-568-C.
    - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems, Cabling Termination Practices."
    - 3. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
    - 4. Optical fiber cabling shall be spliced only at fiber patchpanel splice trays.
    - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
    - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Copper Structured Cabling Systems, Cabling Termination Practices" Section. Install lacing bars and distribution spools.
    - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
    - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
    - 9. Use hook-and-loop straps (3/4" wide minimum) to bundle cable. Do not use zip-ties or other hard plastic straps to bundle cable.
    - 10. In the telecommunications room, install a 10-foot (-long service loop on each end of cable.
  - G. Optical Fiber Cable Installation:
    - 1. Comply with TIA-568-C.3.
  - H. Open-Cable (Free-Wiring, Accessible Areas, and Within Telecommunications Rooms) Installation:
    - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
    - 2. Suspend cable not in a wireway or pathway a minimum of 8 inches (above ceilings by cable supports not more than 60 inches ( apart.
    - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
  - I. Group connecting hardware for cables into separate logical fields.
- 3.3 FIRESTOPPING
- A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."
  - B. Comply with TIA-569-D, Annex A, "Firestopping."
  - C. Comply with BICSI TDMM, "Firestopping Systems" Article.
- 3.4 GROUNDING
- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
  - B. Comply with TIA-607-B and NECA/BICSI-607.
  - C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Administration Class: Class 2.
  - 2. Color-code fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, horizontal pathways and cables, cross-connect hardware and positions, outlet locations, grounding busses and pathways, and equipment grounding conductors.
- D. Cable and Wire Identification:
  - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
  - 3. Label each connector in each cross-connect.
    - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    - b. Label each unit and field within distribution racks and frames.
- E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B.
  - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Visually inspect cable jacket materials for NRTL certification markings.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patchcords, and labeling of all components.
  - 3. Visually confirm category or rating of all cabling and connectors matches specification.
  - 4. Test cables after termination.
  - 5. Optical Fiber Tests:
    - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    - b. Link End-to-End Attenuation Tests:
      - 1) Multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
      - 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA-568-C.1.
    - c. Test each installed permanent link.
- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

- C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 271300



## SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

### 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. UTP horizontal cable.
2. Cable connecting hardware, patch panels, and cross-connects.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.

##### B. Related Requirements:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for structured cabling associated with system panels and devices.
2. Section 274000 "Audiovisual Systems" for structured cabling associated with audiovisual systems.

#### 1.3 ADMINISTRATIVE AND COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner and Owner's authorized agents.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- C. Coordinate location of power connections, mechanical equipment, and lighting fixtures in telecommunications rooms.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Comply with Section 270010 "Communications General Provisions."

#### 1.5 WARRANTY

- A. Comply with Section 270010 "Communications General Provisions."

#### 1.6 ACTION SUBMITTALS

- A. Reference Section 270010, "Communications General Provisions" for additional submittal requirements.
- B. Product Data: For each type of product.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Reference Section 270010, "Communications General Provisions" for additional submittal requirements.

#### 1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Test Results: For every permanent link installed.
- C. Warranty: Documentation of proof of warranty, including extended warranties, for products and systems installed.
- D. As-Builts: CAD/DWG and hardcopy format of project as-builts, indicating locations, routing, quantities, and other pertinent information for final conditions.

## 1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Device Plates: Fifteen (15) of each type.
  - 2. Device Connectors: Ten percent of installed connectors of each type, but not fewer than two.

## 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
  - 1. Test each pair of twisted pair cable for open and short circuits.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1 when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with TIA-607-C.
- E. RoHS Compliant.

### 2.2 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden
  - 2. Berk-Tek
  - 3. CommScope / Uniprise
  - 4. General Cable
  - 5. Superior Essex
- B. Description: 100-ohm, four-pair UTP covered with a thermoplastic jacket.
  - 1. Comply with ICEA S-90-661 for mechanical properties.
  - 2. Comply with TIA-568-C.1 for performance specifications.
  - 3. Comply with TIA-568-C.2, Category 6A.
  - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM or CMG.
    - b. Communications, Plenum Rated: Type CMP, complying with UL1685.
  - 5. Jacket Colors:
    - a. Blue (Data).
    - b. Green (Audiovisual).
    - c. Yellow (Security).
    - d. Red (Fire Alarm).

### 2.3 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden

2. CommScope / Uniprise
  3. Leviton
  4. Ortronics
  5. Panduit
- B. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- C. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- D. Patchpanels: Modular rack-mounted panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus 25 percent spare positions, not to exceed the minimum number of required patchpanels.
  2. Jack Installation: Unpopulated for use with snap-in modular jacks.]
  3. Labeling areas adjacent to connectors.
  4. 48 ports.
- E. Jacks and Jack Assemblies: Modular, color-coded, eight-position (8P8C) receptacle units with integral IDC-type terminals, suitable for snap-in connection to faceplates and patchpanels, plastic construction with housing or snap-in icon color coded as follows:
- a. Colors:
    - 1) Blue (Data)
    - 2) Green (Audiovisual)
    - 3) Yellow (Security)
- F. Patch Cords: Factory-made, UTP four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots.
  2. Patch cords shall have latch guards to protect against snagging.
  3. Patch cords performance category shall match installed communications cabling.
  4. Jacket Colors:
    - a. Blue (Data).
    - b. Green (Audiovisual).
    - c. Yellow (Security).

## 2.4 TELECOMMUNICATIONS OUTLETS & CONNECTORS

- A. Outlet Connectors:
1. UTP Jacks: Reference "UTP Cable Hardware" for description and performance specification.
  2. Mounting: Snap-in style affixed to appropriate faceplate.
- B. Outlet Faceplates: Single- or multi-gang faceplate suitable for accommodating multiple snap-in communications connectors.
1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
  2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
  3. Wall-Phone Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
    - a. Configuration: Recessed connector mounting with phone mounting studs.
  4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

## 2.5 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-C and NECA/BICSI-607.

## 2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

## PART 3 - EXECUTION

### 3.1 WIRING METHODS

- A. Free-Wiring Installation: Install cables above ceilings and within partitions without pathways.
- B. Accessible areas: Install cables using Arlington loops, J-hooks or cable trays.
  - 1. Arlington loops and J-hooks shall be spaced no greater than 60 inches on center.
  - 2. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
  - 3. Install plenum cable in spaces used to convey environmental air.
- C. Inaccessible areas: Install cables using conduits and conduit sleeves.
  - 1. Comply with requirements in Section 270528 "Pathways for Communications Systems."
  - 2. Install plenum cable in environmental air spaces, including plenum ceilings.
- D. Conceal cables where possible. Install cabling in a neat and orderly fashion where visible.

### 3.2 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C.
  - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems, Cabling Termination Practices."
  - 3. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 4. Twisted pair cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Copper Structured Cabling Systems, Cabling Termination Practices" Section. Install lacing bars and distribution spools.
  - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
  - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 9. Use hook-and-loop straps (3/4" wide minimum) to bundle cable. Do not use zip-ties or other hard plastic straps to bundle cable.
  - 10. At the conduit sleeve to the outlet, install a 3-foot-long service loop of cable.
  - 11. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems, Pulling Cable." Monitor cable pull tensions.

- C. Twisted Pair Cable Installation:
  - 1. Comply with TIA-568-C.2.
  - 2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- D. Open-Cable (Free-Wiring, Accessible Areas, and Within Telecommunications Rooms) Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - 2. Suspend cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
  - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA-569-D for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
  - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  - 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
  - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
  - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

### 3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Administration Class: Class 2.
  - 2. Color-code fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, horizontal pathways and cables, cross-connect hardware and positions, outlet locations, grounding busses and pathways, and equipment grounding conductors.
- D. Cable and Wire Identification:
  - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
  - 3. Label each connector in each cross-connect.
    - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    - b. Label each unit and field within distribution racks and frames.
- E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B.
  - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Visually inspect cable jacket materials for NRTL certification markings.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patchcords, and labeling of all components.
  - 3. Visually confirm category or rating of all cabling and connectors matches specification.
  - 4. Test cables after termination.
  - 5. Twisted Pair Tests:
    - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    - b. Test each installed permanent link.
- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.  
END OF SECTION 271500

## SECTION 274000 - AUDIOVISUAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Audiovisual equipment and hardware .
  - 2. Audiovisual cabling.
  - 3. Cabling system identification requirements.
- B. Related Requirements:
  - 1. Division 270528 "Pathways for Communications Systems" for conduits, pathways, enclosures and boxes required to support the work of this Section.
  - 2. Division 271100 Section "Communications Equipment Room Fittings" for equipment racks, frames and power distribution and conditioning appurtenances required to support the work of this Section.
  - 3. Division 271300 "Communications Backbone Cabling" for backbone cabling and hardware required to support the work of this Section.
  - 4. Division 271500 "Communications Horizontal Cabling" for horizontal cabling, outlets and hardware required to support the work of this Section.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: The AV Contractor shall maintain a minimum industry certification for staff members and provide certificates for each.
  - 1. Installers: CTS (AVIXA).
  - 2. Field Supervisor/Lead Technician: CTS-I (AVIXA).
  - 3. Project Manager: CTS-D and/or CTS-I (AVIXA).
- B. Product Data: For each type of product.
- C. Shop Drawings: The AV Contractor shall furnish a complete set of Shop Drawings detailing a complete installation plan, including:
  - 1. Floor Plans: Final outlet and device locations, routing of raceways and cables inside and outside the building.
  - 2. Proposed rack layouts based on submitted equipment.
  - 3. Equipment mounting details.
  - 4. System wiring diagrams: Indicate connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
  - 5. Scaled construction drawings of custom plates and panels from the manufacturer.
  - 6. Drawings for the proposed rigging and placement of the loudspeakers.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Manuals and operational "cheat sheets".
- C. Record documents



1. The Contractor shall maintain record documents throughout the project, indicating 'as-built' conditions.
2. The Contractor shall provide a final set of record documents, in electronic format, to the Owner. The final record documents shall be included with Operation and Maintenance data to be supplied to the Owner at time of project turnover.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product as indicated on Drawings or in this Section, or comparable product.
- B. Listing of approved manufacturers for each component follows component description below.

### 2.2 AUDIOVISUAL EQUIPMENT & COMPONENTS:

- A. The following approved manufacturers, quantities, and model numbers shall form the basis of the system. The AV contractor shall verify all quantities prior to ordering and installation. Quantities are provided for reference only.
- B. The AV contractor shall furnish all equipment and work as noted or implied on the drawings or specifications.
- C. Part Numbers: As indicated on Drawings.
  1. Part numbers listed on the Drawings are provided to define the performance specifications for the parts and shall be per the most recent manufacturer's cut/data specification sheets available at the time of bid.
  2. Where multiple options for manufacturers are not listed, the manufacturer and part number shall be used to define the salient characteristics of the component. Alternate manufacturers may be considered provided salient characteristics of the specified component are met.
  3. Where part numbers listed become obsoleted or fall in the product end-of-life period, the applicable replacement product from the same manufacturer, exhibiting equal or enhanced performance and capability, shall be used. Substitution process in accordance with Section 270010 is not required.
  4. If no part number is provided, then any part meeting the requirements or use indicated or specified is acceptable.

### 2.3 AUDIOVISUAL EQUIPMENT RACKING AND SUPPORT

- A. Rack-mounted Equipment:
  1. Rack-mounted equipment shall be installed per manufacturer's recommendations.
  2. Non-rack-mounted equipment shall be installed on rack-mounted shelf units and be secured via clamping element or other means.
  3. Manufacturers: Match manufacturer of equipment racks provided, comply with Division 27 Section "Communications Equipment Room Fittings".

### 2.4 AUDIOVISUAL WIRE AND CABLE

- A. Acceptable Manufacturers:
  1. Belden Electronics Division.
  2. General Cable.
  3. West Penn Wire.
  4. Comprehensive.
  5. FSR Inc.
  6. Extron, Inc.
  7. Crestron.

- B. Microphone / Line Level Audio Cable shall be 22 AWG, 2 Conductor, twisted pair with stranded bare copper conductors, shielded with an overall jacket (color-coded). Belden Electronics Division 5500FE or equal from Acceptable Manufacturers.
- C. HDBaseT cable shall be 4 pair, 24 AWG with overall foil shield (FTP) and plenum-rated jacket (CMP) Category 6 cabling tested and certified at 250MHz at maximum length 295 ft. Cables shall be certified by the HDBaseT alliance for minimum performance standards. Provide West Penn 254246F or equal.
- D. HDBaseT (POH) shall be 4 pair, 23 AWG with overall foil shield (FTP) and plenum-rated jacket (CMP) Category 6A cabling tested and certified at 500MHz at maximum length 295 ft. Cable shall support maximum 100W Power Over HDBaseT (POH). Cables shall be certified by the HDBaseT alliance for minimum performance standards. Provide West Penn 254246AF or equal.
- E. Passive HDMI Cables shall be pre-manufactured, HDMI 2.0, HDCP 2.2 compliant, 24AWG conductors within cable, NEC Class 2 rated, non-plenum. Support for 4K @ 60Hz, 4:4:4 YuV, 18Gbps. Maximum Length: 20ft. Provide Comprehensive Microflex Pro or equal.
- F. Active HDMI Cables shall be pre-manufactured, HDMI 2.0, HDCP 2.2 compliant, 24AWG conductors within cable, NEC Class 2 rated, plenum. Support for 4K @ 60Hz, 4:4:4 YuV, 18Gbps Maximum Length: 328ft. Provide FSR HDMI 2.0 Active Digital Ribbon DR-H2.0-XX (XX = Length) or equal.
- G. UTP Cable: See Specification Section 271500, "Communications Horizontal Cabling".
- H. Loudspeaker Level Cable shall be 1 pair 18/16/14/12/10AWG stranded copper conductors, unshielded, with an overall jacket (Color Coded). Belden Electronics Division 6200UE/6100UE/6000UE/6T00UP or equal from Acceptable Manufacturers.
- I. Serial Control Cable (RS232, RS485, IR, etc) shall be 2 pair 24AWG Stranded copper conductors, shielded with an overall jacket (Color Coded). Belden Electronics Division 9842 or equal.

## 2.5 CUSTOM AUDIOVISUAL OUTLETS

- A. Acceptable Manufacturers:
  - 1. BTX.
  - 2. Panelcrafters.
  - 3. RCI Custom.
  - 4. Whirlwind USA.
- B. Outlet Plates:
  - 1. Configuration as indicated on Drawings.
  - 2. Metallic: aluminum or steel.
  - 3. Compatible with standard device outlet box.
  - 4. Engraved text adjacent to connectors.
  - 5. Engraved plates or panels shall be filled with a suitably contrasting color, as approved on shop drawings.

## 2.6 PATHWAYS FOR AUDIOVISUAL SYSTEMS

- A. See Specification Section 270528, "Pathways for Communications Systems".

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All equipment and materials shall be installed in accordance with all applicable standards of the national electric code and any other applicable local codes.
- B. All materials and labor shall be furnished, whether specifically mentioned or not, to form complete and fully operational systems. Include the delivery, unloading, placement, fastening to walls, floors, ceiling, or counters, other structures where required, interconnecting wiring of the systems components,

equipment alignment, and all other work whether it is necessary to result in complete operational systems.

- C. All installation activities shall be in accordance with accepted broadcast and audio engineering practices.

### 3.2 INSTALLATION

- A. AV Contractor bears the responsibility to verify all site conditions and coordinate with the Electrical Contractor to ensure a complete and functional system is provided to the Owner.
- B. During installation, until the date of final acceptance, the AV Contractor shall be under obligation to protect finished and unfinished work against damage and loss; such work shall be replaced or repaired at no cost to the Owner.
- C. Wiring Method: Install wiring in raceways except within consoles, desks, and counters. Conceal cables and raceways except in unfinished spaces.
- D. Install exposed cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed to avoid damage to cables. Secure cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.
- F. Separation of Wires: Separate microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for microphones and adjacent parallel power and telephone wiring. Separate other audio/video cabling conductors as recommended by equipment manufacturer.
- G. Taps and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.
- H. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- I. All audio circuits shall be two-wire (balanced) with shield. Balanced connections shall be made with acceptable connectors including XLR, ¼" TRS (tip-ring-sleeve), and Phoenix-type. Connector wiring shall comply with AES48-2005.
- J. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- K. Carefully coordinate requirements with Owner furnished equipment.
- L. Paint all exposed loudspeakers, baffles, and hardware, color and method as approved by Architect.
- M. All control panels, patch panels, jacks, microphone receptacles, switches, etc. (except those on equipment which are properly identified by the manufacturer) shall be suitably identified by engraved panels, engraved plates, metal-photo panels, or metal-photo plates. Engraved plates or panels shall be filled with a suitably contrasting color, as approved on shop drawings.
- N. All nameplate nomenclature shall be reviewed by the consultant prior to panel or plate engraving, or metal-photo finishing.

### 3.3 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables may not be spliced.
- C. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- D. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- E. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
- F. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- G. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
- H. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- I. UTP Cable Installation:
  1. Comply with TIA/EIA-568-B.2.
  2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

### 3.4 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
- C. Install grounding electrodes as specified in Division 27 Section "Grounding and Bonding for Communications."

### 3.5 FIELD QUALITY CONTROL

- A. Perform the following and prepare test reports:
  1. After installing audio/video system equipment and after electrical circuitry has been energized, test for compliance with requirements.
  2. A "Test Plan" shall be formed by the contractor. This "Test Plan" shall describe:
    - a. Suggested tests to be conducted.
    - b. Individual test objectives.
    - c. Acceptable range of results.
    - d. Corrective measures.
    - e. Testing Schedule, including date, times and duration of testing.
  3. The "Test Plan" shall incorporate tests recommended by manufacturers.
  4. The "Test Plan" shall be submitted to the Owner and the Engineer for approval at least 10 working days prior to carrying out any tests.
- B. UTP Cable Testing
  1. UTP Cable Testing shall meet the testing requirements in Division 27 Section "Communications Horizontal Cabling".
- C. The Contractor shall provide written records of test results to the Owner within 15 days of the completion of these tests:
- D. Operational Test: Shall include originating program material at all outputs. Observe sound and video reproduction for proper performance, free from noise, feedback, delay, and echo.
- E. Retesting: Correct deficiencies and retest. Prepare a written record of tests.

- F. Inspection: Verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
- G. Prepare written test reports.

### 3.6 STARTUP SERVICE

- A. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
- B. Complete installation and startup check according to manufacturer's written instructions.
- C. It shall be the responsibility of the AV Contractor to perform preliminary tests and adjustments of the AV system prior to final system commissioning.
- D. These tests and adjustments shall include but not be limited to the following:
  - 1. Testing of each loudspeaker to ascertain that no unit's "rattle" with a nominal pink noise input of 2 watts.
  - 2. Functional tests of all audio equipment.
  - 3. Test for proper polarity of all microphone circuits and microphones.
  - 4. Gain staging of the signal chains for all systems.
  - 5. Initial set-up of all DSP's to include; set-up of initial signal routing, crossovers, equalization filters, delays, and levels.
    - a. AV Contractor shall submit the preliminary set-up file for the Audio DSP units to the Consultant for review.
    - b. The AV Contractor shall then initially adjust the sound systems equalization in all rooms to provide an overall flat frequency response throughout the areas covered by the sound systems.
  - 6. The AV Contractor shall program all control systems to provide functions as required to select video sources and control projectors.
    - a. The AV Contractor shall test all control and controlled equipment for proper functioning.

### 3.7 MANUALS AND DOCUMENTATION

- A. Each room and each system shall have one operations cheat sheet.
  - 1. Cheat sheets shall explain in simple terms the shortest possible way to turn the system on or off, how to select playback devices, and how to operate the television and Blu-Ray player.
  - 2. Cheat sheets shall be typewritten or drafted CAD.
- B. Provide two (2) combined Operations and Maintenance Manuals, two ring-bound, one flat bound for filing with building reference documents.
  - 1. O&M Manuals shall be of sufficient detail that a person of adequate technical ability may perform routine maintenance, recognize and replace malfunctioning equipment, and contact the proper entity for service on the faulty equipment.
  - 2. O&M Manuals shall be typewritten, drafted CAD, or original manufacturers' documents.
  - 3. O&M Manuals shall contain the cheat sheets, equipment serial numbers, product data submittals, test data, system description summary, functional diagrams, maintenance tasks and schedules, manufacturers' warranties, and contact information for the Contractor.
- C. Submit three (3) sets of full-size record drawings to Owner.
  - 1. The record drawings shall incorporate all field modifications and shop drawings.
  - 2. A PDF copy shall be transmitted to the Owner.
- D. A copy of all DSP and control system settings shall be copied to a USB flash drive and placed in the equipment cabinet/rack that housed the respective equipment upon completion and final acceptance.

### 3.8 DEMONSTRATION AND TRAINING

- A. Train Owner's personnel to adjust, operate, and maintain audio/video system equipment.

END OF SECTION 274000

## SECTION 274116 - PERFORMANCE AV SYSTEMS

### PART 1 GENERAL

#### 1.01 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions.

#### 1.02 RELATED SECTIONS AND DOCUMENTS

- A. Performance AV Systems (AV) Drawings.
- B. Division 01 – General Requirements:
  - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- C. Division 26 – Electrical:
  - 1. The Electrical Contractor shall provide the work as specified in Division 26, as indicated on the AV Drawings, and as specified herein.
  - 2. Electrical infrastructure (electrical j-boxes, conduit) for AV systems is shown on AV drawings and shall be the responsibility of the Division 26 Electrical Contractor.
  - 3. Conduit, wire, and electrical termination of control signal from building fire detection/alarm system to the AV control system.

#### 1.03 RELATED WORK

- A. AV Contractor shall coordinate with Electrical Contractor on raceway/junction box locations for audio-video equipment and routing of audio, video, control, and power cables/raceway from equipment, terminal and pull boxes to system equipment racks.
- B. AV Contractor shall coordinate with Theater Systems Contractor on projection screen location and mounting details.
- C. AV Contractor shall be responsible for the coordination of equipment and materials provided and installed by others where they relate to AV systems, unless otherwise shown in this Section or the Drawings, shall include but are not limited to:
  - 1. Electrical Outlets
  - 2. Floor boxes
  - 3. Furniture
  - 4. Conduit, Raceway and Cable Tray
  - 5. Junction Boxes
  - 6. Telecommunications Outlets
  - 7. Lighting Control Devices
  - 8. Building Management Systems

## 1.04 DEFINITIONS

- A. The following shall serve as general identifiers as specified herein:
1. Owner – Campbell County School District
  2. Consultant – D. L. Adams Associates.
  3. Architect – Plan 1 / DLR Group.
  4. Contractor – The Contractor is the firm submitting a proposal to furnish and install the Work as defined within this Specification.
  5. Project – The Project is the Audio and Video Systems and installation for the Auditorium and support areas of the new addition to Campbell County High School.
  6. Work – The term “Work” means all construction and services specified within this document. The Work includes all related labor, materials, equipment, and services provided, or to be provided, by the Contractor to fulfill the proposal’s obligations.
  7. Drawings – The term “Drawings” means all AV Systems Drawings and associated sketches, details, riser diagrams, etc.
  8. Project Location – Gillette, Wyoming.
- B. As used in the Drawings and Specifications for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.
1. “Furnish” – Purchase and deliver to the project site complete with every necessary accessory and support hardware and equipment, all as part of the Audio-Video Systems Work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to ensure that purchased items are free of all liens, claims, or encumbrances.
  2. “Install” – Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the Work.
  3. “New” – Manufactured within the past year and never used.
  4. “Provide” – Furnish and Install.
- C. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as described to them in the following list:
1. “Audio-Video Closet” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of Audio-Video Systems cable (i.e. riser cable) to other Audio-Video Systems cable and/or equipment.
  2. “AV” – Audio-Video
  3. “AVC” – Audio-Video Systems Contractor.
  4. “AV System(s)” – Audio-Video System(s), includes all components contained herein that work in conjunction to create and completely integrated and fully functioning system as described within the Drawings and Specifications
  5. “AV Systems Control Room” and/or “AV Systems Headend” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of audio and video system cable (i.e. riser cable) to other audio or video system cable, and/or equipment and racks.
  6. “Circuit” – Any specific run of circuitry.
  7. “Circuitry” – Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes,



joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.

8. "Concealed" (as applied to circuitry) – Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.
9. "Exposed" (as applied to circuitry) – Not covered in any way by building materials.
10. "NIC" – Not in Contract
11. "Normal Work Conditions" – Locations within building confines that are not damp, wet, or hazardous and that are not used for air handling.
12. "OFE" – Owner Furnished Equipment
13. "Patch Panel" – A System of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.
14. "Raceway" – Any pipe, duct, extended enclosure, or conduit (as specified for a particular System) which is used to contain wires, and which is of such nature as to require that the wires be installed by a "pulling in" procedure.
15. "Riser" – Shall refer to the portion of the installation that transmits between building floors (or between Audio-Video Systems rooms), also referred to as "Backbone Cabling".
16. "Standard" (as applied to wiring devices) – Not of a separately designated individual type.
17. "System" – See "AV Systems"
18. "Wiring" – See "Circuitry"

D. Additional Terms

1. The term "shall" is mandatory; the term "will" is informative; the term "should" is advisory; and the term "provide" means furnish and install.
2. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".
3. The term "custom" indicates systems or components that shall be designed and fabricated by the Contractor based on the drawings and specifications.
4. The term "future" indicates systems or components that will be added to the system later but shall be provisioned for now.
5. The term "equal" indicates systems or equipment that is of the same size, color, design, function, efficiency, etc. as of that specified.
6. Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety" published by Underwriters Laboratories, Inc

## 1.05 SCOPE OF WORK

A. General:

1. The work as described herein shall be furnished and installed by one firm alone, hereafter referred to as the AV Contractor. The AV Contractor shall furnish and install all equipment, and audio/video signal and control wiring for the AV Systems described herein. The Contractor further agrees that they shall provide all Work as may be required to make a complete and fully functioning system of that which may not be fully defined in the Contract Documents.
2. The specifications and drawings shall be read and used together, system features which are mentioned in one are not necessarily shown in the others. In case of conflict between the drawings and specifications, request clarification. It shall be understood that the Equipment Lists, Specifications and Drawings are complementary. Where there are conflicts within the documents, the overall design intent shall govern.

3. The work provided shall be complete and the systems shall be fully operational as shown on audio-video system "AV" drawings and described in Paragraph 1.7 herein.
  4. Equipment not mentioned herein nor shown on drawings but necessary to meet the requirements of this section shall be provided without claim for additional payment.
  5. The project documentation is, in general, diagrammatic and/or developed to communicate design intent. The Contractor shall coordinate the installation of all devices and/or equipment with the Owner prior to installation based on the existing field conditions.
  6. The AV Contractor shall coordinate all installed items with associated trades (electrical, mechanical, Telecom, etc.) including all necessary cable pass-thrus and structural needs/requirements including backing, etc.
  7. The AV Contractor shall provide all software programming required to provide fully operational systems.
  8. The AV Contractor shall conduct a frequency audit of the site prior to selection of wireless operating frequencies. Select frequencies such that systems are free of interference. Include an intermodulation interference analysis. Coordinate frequencies and specific transmitter/receiver selection using professional wireless audio systems software.
  9. The AV Contractor shall coordinate the specific programming requirements of the AV control system with a designated Owner representative, including touch screen layouts and page navigation. The AV Contractor must ensure that the functionality of the control system required by the Owner is met, this shall include additional meetings and programming time. The AV Contractor shall provide the resources necessary to meet those expectations. AV Contractor must make additional adjustments to the control system in accordance with Owner feedback. Additionally, the AV Contractor shall be required to make updates requested to the control system for a minimum of two (2) months after final acceptance. All programming written for this project shall be the property of the Owner and shall be provided to the Owner upon completion.
  10. Digital video systems in this design shall employ an EDID management strategy and shall be HDCP compliant.
- B. Work Included Elsewhere
1. Installation of raceway, pull-boxes, plywood backboards and floor-boxes (provided under electrical Work). Coordination is required within the design to verify the appropriate raceways are in place.
  2. Installation and termination of network systems except dedicated AV network systems.
  3. Cutting, patching and painting of walls, unless damaged performing the work described herein.
- C. Coordinated Work
1. Coordinate with related trades to schedule the Work and ensure a complete installation in accordance with the schedule outlined by the Owner.
  2. Coordinate all IP device requirements with the Telecom Contractor, Owner, and General Contractor.
  3. Coordinate all building network connectivity requirements with the Telecom Contractor and Owner.
  4. Coordinate furniture and custom millwork with furniture and millwork providers.
  5. Coordinate structural backing and support requirements with General Contractor.
  6. AV Contractor shall participate in pre-construction conferences with General Contractor, Electrical Contractor, Theatre Contractor and Design Team to coordinate new electrical conduit and equipment routing and locations prior to installation.

## 1.06 GENERAL CONDITIONS

- A. The Contractor represents that they are familiar with and have expertise in the Work of this nature and scope.
- B. The Contractor shall comply with all the regulations, including the safety regulations of national, city, local and other government agencies having jurisdiction concerning the work of the Contractor. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules, and regulations bearing on the conduct of the Work. If the Contractor performs any work, which is contrary to such laws, ordinances, codes, rules and regulations, they shall make all changes for compliance and bear all associated costs.
- C. The Contractor shall be responsible for providing and maintaining a storage facility as required. If this storage facility is required to be on-site it shall be the Contractor's responsibility to coordinate the size and spatial requirements with the General Contractor. The Contractor shall assume full responsibility for the storage facility and all contents, unless otherwise indicated by the Owner.
- D. The Contractor shall provide all protection necessary to safeguard their work from damage by their operations and the operations of others. Unless the Contractor proves to the Owner's satisfaction that the Work has been damaged by others, the Contractor shall promptly repair, adjust, and clean all defective installations and bear all associated costs.
- E. All the Contractor's work shall be tested and inspected by all authorities having jurisdiction and in accordance with all specifications. The Contractor shall coordinate and cooperate fully and shall provide at no additional cost to the Owner, manpower, drawings, facilities, scaffolds, etc. to reasonably assist the inspectors.
- F. The Owner reserves the right to furnish any materials necessary for the Project.
- G. All permits required for any part of the Contractor's work shall be procured and paid for by the Contractor. The Contractor shall determine all permits required and transmit this information to the Owner. If it is determined that the Contractor's work falls reasonably within another party's permit (General Contractor, Electrician, etc.) the Contractor shall not be required to procure additional permits provided written authorization is provided to the Contractor by the party holding the permit.
- H. The Contractor must state if they intend to utilize a Subcontractor and provide said Subcontractor's name and address. The Subcontractor shall comply with all the same rules, regulations, laws and codes, licenses, etc. as required by the Contractor and as specified herein. The Owner and/or Consultant reserves the right to approve or disapprove any Subcontractor proposed by the Contractor.
- I. The Contractor, upon receiving notice from Owner and/or Consultant that the Contractor has furnished inferior, improper or unsound work or materials (including equipment), or work or materials at variance with that which is specified, will, within 24 hours, proceed to remove such

work or materials and make good all other work or materials damaged thereby, and, at the option of the Owner, the Contractor shall immediately replace such work or materials with work or materials as specified. The removal, replacement, and repair shall be performed at such times and with manpower sufficient, in the judgment of the Owner, so as to avoid disturbance to occupants, or other ongoing work for the Project.

1. If the Contractor does not remove such unsound Work within a reasonable time, the Owner may remove it and may store the material at the expense of the Contractor. If the Contractor does not pay the expenses of such removal within ten (10) days' time thereafter, the Owner may, upon written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Contractor and all expenses of the sale.
  2. The Owner shall have the authority at all times, until final completion and acceptance of the Work, to inspect and reject work and materials which in its judgment are not in conformity with the Drawings and Details, Room Data Sheets and Specifications, and its decision in regard to character and value of Work shall be final and conclusive on both contracting parties. If the Owner permits said Work or materials to remain, the Owner shall be allowed the difference in value or shall at its election have the right to have said Work or materials repaired or replaced, as well as the damage caused thereby, at the expense of the Contractor, at any time within one (1) year after the completion of the entire project, or within such longer period as may be covered by any guaranty; and neither payments made to the Contractor, nor any other acts of the Owner, shall be construed as evidence of acceptance, waiver, or estoppels.
  3. Any expense incurred by the Owner in connection with the foregoing shall be borne by the Contractor, and the Owner may withhold money due to the Contractor or recover money already paid to the Contractor, to the extent of such expense.
- J. The Drawings for the Work utilize symbols and schematic diagrams that have no dimensional significance. The Work shall be installed to fulfill the diagrammatic intent expressed on the Drawings, field layouts, and shop drawings of all trades.
- K. Certain details appear on the Drawings for the Work that are specified regarding the dimensioning and positioning of the Work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated Work.
- L. Information as to general construction and architectural general construction and architectural features and finishes shall be derived from the structural and architectural drawings and specifications and may require ongoing coordination with the Architect and/or Construction Team.
- M. The Work called for under this Contract shall be carried on simultaneously with the Work of other trades and Owner functions in such a manner as to not delay the overall progress of the construction project. The Contractor is responsible for all coordination of the Work with other trades and Owner.
- N. Include in the Work all necessary supervision and issuing of all coordination information to any other trades who are supplying work to accommodate the Audio-Video Systems installation. For

items of equipment which are to be installed but not purchased as part of the Work, the Work shall include:

1. Coordination of delivery
  2. Unloading from delivery trucks
  3. Safe handling and field storage up to the time of permanent placement in the project
  4. Correction of any damage to the item(s) caused by the Contractor
  5. Mounting in place and connection(s) as specified
- O. Items which are to be installed, but not purchased as part of the Work, shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the Work will be considered only if presented in writing within one (1) week of the date of delivery to the project of the items in question. The Work includes all procedures necessary to put in satisfactory operation all items for which no claims have been submitted as outlined above.

## 1.07 SUMMARY

### A. System Summary

1. The Auditorium AV systems will provide high quality voice and foreground music reinforcement for theatrical, musical, or presentation type events. Additionally, the system will be designed to allow recording of audio material as well as playback of prerecorded audio material. Video projection systems will be provided for displaying video material.

## 1.08 SYSTEM DESCRIPTIONS AND FUNCTIONS

- A. The Auditorium and backstage support areas AV system shall consist of, but not be limited to, the following subsystems, equipment, and functionality.
1. Dedicated Audio Video Network:
    - a. A dedicated audio video network shall be provided. It shall be the responsibility of the AV Contractor to provide and configure the AV network for the optimal transmission of digital audio, digital video, and control system protocols. AV Contractor shall coordinate all IP addresses and network protocols with Owner IT staff.
    - b. The AV network shall consist of PoE+ network switches located in AV equipment racks. It shall be the responsibility of the AV Contractor to supply all necessary switch accessories to meet the network bandwidth and PoE+ power performance requirements of the AV equipment specified herein. AV Contractor shall coordinate exact network switches with Owner IT, DSP, network video, and control system manufacturers before ordering network switches. Network switches included in the equipment list are included as a basis of design only, AV Contractor is responsible for providing and installing switches that meet or exceed all equipment network requirements.
    - c. The dedicated AV network shall employ a network video distribution system within the Auditorium and support areas allowing all dedicated AV network video sources to be routed to all AV network video outputs.
    - d. Network traffic shall be partitioned as needed to separate network applications by type for optimum performance.

- e. The AV Contractor shall coordinate with the switch manufacturer for support, as required, to properly configure the AV network, including remote or on-site manufacturer switch configuration as necessary.
  - f. Network patch panels shall be provided for the termination of network cables originating from outside the AV equipment rack.
  - g. All network cabling provided by the AV Contractor shall adhere to the applicable Category 6A standards. AV Contractor shall provide test reports prior to system checkout documenting compliance with applicable standards for all installed network cables.
2. Audio System:
- a. The audio system shall provide high quality dynamic sound reinforcement for theatrical productions, music performances, and presentations. The system shall allow for the playback of prerecorded audio material and the recording of events.
  - b. The main sound reinforcement system shall have a center main loudspeaker cluster permanently mounted within the forestage canopy to provide even coverage throughout the Auditorium. Dedicated sub-bass loudspeakers shall be integrated with the main cluster to extend the frequency response.
  - c. Audio inputs/outputs shall be distributed throughout the auditorium stage and surrounding areas including plate locations at stage right, stage left, upstage left, upstage right, and in the catwalk. All stage inputs shall be routed to a patch bay mounted in the Stage Manager's rack.
  - d. A dedicated room microphone shall be aimed at the stage from the catwalk structure. The room mic shall be controlled via the DSP and routed to backstage support areas. Audio from the dedicated room microphone shall be integrated with the audio systems in the music classrooms that are provided by others. AV Contractor shall coordinate the required connection with the music classrooms AV systems provider.
  - e. Receptacles shall be distributed over the stage area to support miniature ceiling mounted choir microphones to provide even coverage of the area for additional vocal support when needed. The exact location of the microphones shall be coordinated with the Theatre Systems provider to avoid interference with Theatre Systems and must not be within the projection cone of permanently installed video projection equipment.
  - f. A digital mixing console and associated digital snakes shall be provided to support audio reproduction and live reinforcement in the auditorium. The digital mixing console must have a minimum of 33 faders, 48 input channels, and 36 mix busses. The mixing console must be capable of being relocated from the Control Room to the house mixing position at the Owner's discretion. The digital console shall have a minimum of three (3) admin level presets for console configuration. A theatre preset will have all wireless microphones, all program inputs, and the dedicated stage inputs. The music preset will have four (4) wireless microphones, all program inputs, the dedicated stage inputs, and ceiling microphones. The third admin preset shall be coordinated with the Owner. All admin presets must require the console admin password to overwrite but shall have all modifications savable to other user presets on the user level password.
  - g. A permanent rack mounted snake head shall be provided in the amplifier rack to facilitate input and output connections to permanently installed equipment. A custom patch panel should be provided to allow users to patch the mixer to the snake head based on the control location.

- h. A portable 16-channel snake head shall be provided to simplify the connection of audio devices. The portable snake head will connect to the dedicated AV network using Dante to maintain a consistent configuration with the digital mixing console.
- i. A combination CD and solid-state media player shall be provided at the sound mixing position equipment rack.
- j. A stereo solid-state recorder shall be provided at the main sound mixing position equipment rack.
- k. A minimum of thirty-two (32) wireless microphone receivers shall be provided. Audio signals shall be routed via network audio transport protocols. Two (2) shall be shared with all control system operational modes. All shall be available to the digital mixing console for the performance mode. Compatible transmitters shall be provided including twelve (12) handheld transmitters and thirty-two (32) bodypack transmitters. Thirty-two (32) head-worn microphones and eight (8) lavalier microphones shall be provided to be used with the body pack transmitters.
- l. Remote wireless microphone antennas shall be mounted in the stage area to provide even coverage of the performance area. The antennas shall be distributed to each receiver via splitters. RF signal amplifiers and accessories shall be provided as required for adequate signal strength.
- m. Consumer inputs shall be provided in the Stage Manager's rack and the sound mixing position equipment rack for the connection of portable devices when needed.
- n. A dedicated microphone with a push-to-talk momentary switch shall be provided at the Stage Manager's rack to make announcements through the backstage support area's monitor speakers.
- o. Audio from program video sources shall be routed through the DSP and provided to the digital mixing console when the control system is in Performance mode.
- p. A digital signal processor (DSP) shall be located in the main AV equipment rack to provide audio processing including equalization, volume control, and signal routing of analog and network audio signals. The digital signal processor must provide discrete outputs to support independent loudspeaker zones with equalization, delay, and volume controls. The DSP must provide mixing of dedicated audio sources when the control system is in simple presentation mode. The DSP will be used to route audio sources to the Auditorium mixing console as a pass-through when the control system is in performance mode. Dedicated inputs shall be provided to the DSP for the simple presentation control system mode. Inputs shall include the Stage Manager's consumer input, lectern receptacle in the stage left floor box, video program audio, and the first two wireless microphones. A backstage monitoring/paging system shall be provided through the DSP.
- q. An ADA-compliant assistive listening system (ALS) shall be provided. The system shall consist of an RF transmitter located in the Amplifier rack with an antenna remotely located on a wall in the Auditorium. Body pack receivers, earphones, and telecoil neck loops (for use with hearing aids) shall be provided. The quantity of all receivers and accessories shall be as required by current ADA standards based on the final occupancy of the Auditorium. AV Contractor shall coordinate mounting of compliance signage with GC and Architect.
- r. Power amplifiers with sufficient power based on loudspeaker requirements shall be provided in the Amplifier rack. The main loudspeakers shall be bi-amped to power the high frequency drivers independently of the low frequency drivers. Each subwoofer driver should be powered independently.

- s. Two foldback monitor mixes shall be provided with monitor receptacles distributed throughout the stage and catwalk wall plates and in the stage floor boxes. A line-level distribution amplifier shall be provided in the Amplifier rack to support the distributed monitor connections distributed throughout the Auditorium.
  - t. Self-powered, portable stage monitor loudspeakers consisting of a 2-way system with a minimum 12-inch low frequency driver shall be provided as loose equipment.
  - u. Local volume controls shall be provided in the control booth, each dressing room, Fashion Design room, and the scene shop.
  - v. Flush mount ceiling speakers shall be provided in the dressing rooms and Fashion Design room.
  - w. Surface mounted speakers shall be provided in Scene Storage and Control Room.
  - x. A quantity of wired instrument microphones, wired vocal microphones, direct boxes, and other loose equipment including cables, stands, and other required accessories shall be provided.
  - y. An audio monitor feed shall be embedded with the video monitor feed and provided to the Lobby display and music classrooms.
3. Video System:
- a. The video system shall provide high-quality video images distributed through a network video system consisting of network video encoders and decoders. The video system must support WUXGA (1900 x 1200) resolution and be UHD (3840 x 2160) capable with ultra-low latency. Video signal routing shall be directed through the control system to send any source to any destination using the AV System's touch screen controllers.
  - b. Video encoders shall be located in the downstage left stage floor box, the Stage Manager's rack, and at the main sound mix position for the connection of portable video sources, such as a laptop computer..
  - c. A Blu-Ray player with a dedicated network video encoder shall be provided at the Stage Manager's rack.
  - d. A PTZ camera including required licenses shall be located on the rear wall of the Auditorium house. The primary function of the camera will be to provide an audience point-of-view image of the stage. Additional presets shall be recallable through the control system to support presenter magnification and other user-definable setups.
  - e. A portable network video encoder shall be provided for portable video equipment such as a laptop, camera, or dedicated conductor camera to be connected to any AV network receptacle.
  - f. A wide screen (WUXGA) video projector with a zoom lens shall be provided. The projector shall be a laser projector with a minimum brightness of 19,000 lumens. The projector shall include all required accessories to precisely fill the projection screen.
  - g. A 16:10 widescreen format, tab-tensioned electric video projection screen shall be provided to the proscenium wall, above the ceiling cloud. The control system shall be the primary controller of the projection screen operation. A 3-position control service switch shall be provided in the Stage Manager's rack for backup screen operation without the control system.
  - h. A rackmount video monitor shall be provided for camera setup and monitoring video content as well as a monitor for the scenic projectors calibration PC.
  - i. A single channel recording and streaming media processor shall be provided in the Stage Manager's equipment rack with a dedicated network video decoder to capture and stream live events from the Auditorium to local solid-state media and/or an



- internet video service such as YouTube. AV Contractor shall coordinate streaming requirements with Owner.
- j. Confidence monitors shall be provided in the stage wings. Confidence monitors shall share a common source from the theatre network video distribution system but should have individual on/off control.
  - k. A video display shall be provided in each Dressing Room. Backstage video displays shall have a common source from the theatre network video distribution system.
  - l. Network video decoders shall be provided to each music classroom for integration with the classroom systems. AV Contractor shall coordinate system integration with classroom systems provider.
  - m. Two (2) widescreen video projectors shall be suspended from a batten over the stage for use as scenic projectors. Dedicated alignment cameras and manufacturer's software shall be provided to assist with the setup and calibration of the blended image between the projectors. AV Contractor shall coordinate mounting and cable requirements with Theatre Systems provider. Optimum settings shall be used, based on field conditions, to create a single, blended image that best fills the upstage cyclorama.
4. Production Intercom:
- a. A 2-channel wired production intercom system shall be provided to allow for communication between stage technicians and backstage areas. One channel shall be dedicated to the distributed auditorium receptacles, while the other channel shall be dedicated to the back of house speaker stations.
  - b. Receptacles at the main mix position and Stage Manager's rack shall allow for the connection of 2-channel beltpacks to support technician communication as well as backstage cueing.
  - c. Beltpack receptacles shall be distributed throughout the Auditorium.
  - d. Speaker stations shall be provided in back-of-house areas, including dressing rooms, scene shop, and music rooms for talent cueing.
  - e. A minimum of nine (9) single-channel and three (3) dual-channel intercom beltpacks shall be provided. Professional grade single-ear closed back headsets including a high-quality dynamic cardioid microphone shall be provided to be used with the beltpacks.
  - f. Ruggedized 3-conductor and 6-conductor cables of assorted length shall be provided to connect the beltpacks to wall receptacles.
5. Support Equipment:
- a. A floor-standing, pivoting Stage Manager's equipment rack with locking front door shall be located downstage left and will house a touchscreen control panel, wireless microphone equipment, Blu-ray player, video and audio inputs, intercom main station, digital snake head, and stage patch panel. Rear rack rails shall be provided to mount the digital snake head in the rear of the rack. Rear rails must be positioned such that the rack can be fully closed and locked without interfering with connected equipment.
  - b. A floor-standing equipment rack with locking doors shall be provided in the AV Amplifier Room to house all processing, amplification, video distribution, and audio-video network equipment.
  - c. A locking rolltop desk including an equipment rack shall be provided at the house mix position to house equipment requiring user adjustment, including the mixing console and touchscreen controller when the position is used for production. The desk will be shared with the lighting control system. AV Contractor shall mount a power strip in

- each control bay of the desk to provide convenience power for user provided devices and coordinate equipment locations with Theater Systems Contractor.
- d. An under-counter equipment rack shall be provided at the mix position in the Control Room to house equipment requiring user adjustment including the media player, audio recorder, and AV inputs including a video transmitter. The Control Room will be shared with the lighting control system. AV Contractor shall mount a power strip in each control bay of the desk to provide convenience power for user provided devices and coordinate equipment locations with Theater Systems Contractor.
  - e. Power distribution and sequencing/control shall be provided in each equipment rack. Uninterruptable power supplies shall be provided for critical equipment including, but not limited to network switches, digital signal processors, control processors, digital mixing consoles, and digital snake heads.
6. Control System:
- a. A central control system shall be provided to integrate and simplify equipment controls and user functions.
  - b. The control system shall monitor all equipment that provides bidirectional feedback and report any failures or errors to Owner designated representatives. Coordinate communication method (e-mail, etc.) with Owner.
  - c. Touchscreen controllers shall be provided at the Stage Manager's rack and each audio mix position.
  - d. Provide control app mirroring touchscreen for Owner-provided portable devices. Coordinate use of Owner wireless network and access permissions with Owner IT if desired by owner.
  - e. The control system shall accept a contact closure signal from the Fire Alarm System (provided by others) and Emergency Paging System (provided by others) to mute audio system.
  - f. A contact closure signal from the paging, clock, and bell system (by system provider) shall be connected to the control system and must mute audio when the system when required. Confirm schedule requirements and performance overrides with Owner.
  - g. The control system shall allow a user to select between two control modes: "Presentation Mode", and "Performance Mode."
    - 1) Presentation Mode shall allow everyday users with little training to operate the system during simple events using the stage. This mode shall be controlled by a touchscreen and not require an operator or the use of the mixing console. This system shall be adequate for lectures, assemblies, movies, community meetings, and simple events where no more than three microphones will be used for speeches or small presentations.
    - 2) Performance Mode shall allow an advanced user the ability to provide sound reinforcement for events with multiple microphones, such as amplified performances. This mode will use a mixing console to control audio sources.

- h. In Presentation Mode, the touchscreen control shall provide concise, consolidated controls for all dedicated equipment and functions including, but not be limited to the following:
- 1) Fully develop touchscreen options and layouts through the process described herein.
  - 2) General:
    - (a) Power the system on/off (note: provide shutdown conformation)
    - (b) PIN or password lock, if requested by Owner
    - (c) Change modes (note: provide mode change conformation)
    - (d) Audio level controls should include a level meter, fader, and +/- step controls. Step controls should be a minimum of  $\pm 1.0$  dB and a maximum of  $\pm 3$  dB per step. The fader range should be appropriate for the applicable range of the audio system. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which audio ceases to be heard. The associated channel mute should automatically activate when the fader is at the low limit.
    - (e) Button type controls shall include logical colors and text to indicate the state of the control function.
    - (f) Provide an indication of user input for any function not immediately recognizable in addition to an indication the function is complete.
    - (g) Provide master audio level control, meter, and mute on all pages.
    - (h) Separate tabs, or pages, shall be created based on logical groups of functions and devices. A separate tab should be created for the main audio mix as well as each monitor mix.
  - 3) Audio Page:
    - (a) Lectern microphone level control, meter, and mute.
    - (b) Wireless microphone 1 & 2 level controls, meters, and mutes.
    - (c) Stage Manager's consumer input level control, meter, and mute.
    - (d) Video program audio level control, meter, and mute.
    - (e) Audio mix and mute options for both the main speakers as well as monitor channels shall be provided.
    - (f) Mute all audio inputs dedicated to Performance Mode and the direct speaker inputs.
  - 4) Bluetooth/Consumer Input Page:
    - (a) Bluetooth pairing controls.
    - (b) Input level controls, meters, and mutes.
  - 5) Blu-ray Player Page:
    - (a) Blu-ray player transport controls.
    - (b) Main menu access with navigation and selection control.
    - (c) Blu-ray player audio level control, meter, and mute.
    - (d) Blu-ray player feedback information including album title, track number, track title, and track time.

- 6) Video Page:
  - (a) Video source selection
  - (b) Video source device remote control
  - (c) Power the video projector on/off (Note: automatically turn on display when a video source is selected. Turn off displays and cool down projector, if required, when the system is turned off.)
  - (d) Provide separate display on/off controls.
  - (e) Video mute
  - (f) Raise/lower the main projection screen.
- 7) Scenic Projector Video Page:
  - (a) Video source selection
  - (b) Power the video projectors on/off
  - (c) Video mute
  - (d) Calibration page with instructions for calibrating projectors.
- 8) Video Recorder/Streamer Page:
  - (a) Recorder transport controls including record, stop, pause, and mark.
  - (b) Streamer transport controls including start, stop, and mute.
  - (c) Dedicated source selection.
  - (d) Dedicated output audio level control, meter, and mute.
  - (e) Feedback information including album title, track number, track title, track time, and stream information.
- 9) Service Page (PIN lock service page)
  - (a) Indicate projector lamp hours.
  - (b) Provide service contact information.
  - (c) Display monitored devices errors.
  - (d) Monitor UPS battery replacement schedule.
- i. In Performance Mode, available touchscreen control options shall include, but not be limited to the following:
  - 1) Fully developed touchscreen options and layouts through the process described herein.
  - 2) General:
    - (a) Power the system on/off (note: provide shutdown conformation)
    - (b) PIN or password lock, if requested by Owner
    - (c) Change modes (note: provide mode change conformation)
    - (d) The touch screen controller at the main mix position should be the only active controller in Performance Mode. All other touch screen controllers should be locked out. Provide locked screen with text notes directing users to the main mix position. Returning the system to Presentation Mode from the main mix position touch screen must unlock all other controllers.
  - 3) Audio Page:
    - (a) Route all audio sources to mixing console in performance mode. Provide screen with text note directing users that the mixing console is in control of audio system.
    - (b) Provide DSP input and output level meters.
    - (c) Mute all DSP audio inputs dedicated to Presentation Mode.
    - (d) Provide a mute for direct speaker inputs, Default should be a muted setting.

- 4) Bluetooth/Consumer Input Page:
  - (a) Bluetooth pairing controls.
  - (b) Input level controls, meters, and mutes.
- 5) Blu-ray Player Page:
  - (a) Blu-ray player transport controls.
  - (b) Main menu access with navigation and selection control.
  - (c) Route audio through DSP to mixing console.
  - (d) Blu-ray player feedback information including album title, track title, track number, track time.
- 6) Video Page:
  - (a) Video source selection
  - (b) Power the video projector on/off (note: in Performance Mode, do not automatically turn on projector when a video source is selected. (Provide separate on/off control)
  - (c) Video mute
  - (d) Raise/lower the main projection screen. (Note: in Performance Mode, do not automatically raise or lower projection screen with any other control)
- 7) Scenic Projector Video Page:
  - (a) Video source selection
  - (b) Power the video projectors on/off
  - (c) Video mute
  - (d) Calibration page with instructions for calibrating projectors.
- 8) Video Recorder/Streamer Page:
  - (a) Recorder transport controls including record, stop, pause, and mark.
  - (b) Streamer transport controls including start, stop, and mute.
  - (c) Dedicated source selection.
  - (d) Dedicated output audio level control, meter, and mute.
  - (e) Feedback information including album title, track number, track title, track time, and stream information.
- 9) Service Page (PIN lock service page):
  - (a) Indicate projector lamp hours.
  - (b) Provide service contact information.
  - (c) Display monitored devices errors.
  - (d) Monitor UPS battery replacement schedule.

## 1.09 QUALITY ASSURANCE:

- A. Applicable Standards and Codes: In addition to all applicable local and state codes, the work shall be in accordance with the latest revisions of all applicable standards and specifications of the following:
1. NAB – National Association of Broadcasters
  2. UL - Underwriters Laboratories
  3. EIA - Electrical Industries Association
  4. NEC - National Electrical Code
  5. AVIXA – Audiovisual and Integrated Experiences Association
- B. AV Contractor's Qualifications:
1. The work of this section will be contracted to a single firm, referred to as the AV Contractor, for undivided responsibility.
  2. The AV Contractor shall be experienced in the installation of professional AV systems and have completed within the past five years at least three AV system projects of a size and scope comparable to the project described herein.
  3. The AV Contractor shall have factory-certified programmers for the programming of any processing and control equipment used in this project. The AV Contractor shall have a manufacturer certified programmer on staff for any specialized equipment requiring programming for the duration of this project.
  4. The AV Contractor shall have capabilities and in-house facilities for installation, shop fabrication and repair service of professional AV systems.
  5. The AV Contractor shall have on their full-time payroll at least one staff engineer having a minimum of five years of experience as a professional AV designer. In place of a qualified staff engineer, the AV Contractor may retain a consulting engineer to direct the project. Prior to bid acceptance, the qualifications of the consulting engineer shall be submitted for the approval of the Consultant. Said staff or consulting engineer shall:
    - a. Provide all technical liaisons between the AV Contractor and the Consultant.
    - b. Represent the AV Contractor at meetings, conferences calls, and be present at the job site for all inspections.
    - c. Be responsible for supervision of all technical and engineering work required executing the contract, approving, and signing the shop drawings.
  6. All Contractors desiring to submit bids for the installation of the audio systems specified herein, not listed in below must be qualified in writing by the Consultant by addendum prior to the bid opening.
  7. Bids submitted by Contractors who have not been qualified will not be accepted.
  8. Contractors not listed below, desiring to bid on this installation, shall submit the required qualification statement of Paragraph 1.10.B. Qualification shall be subject to Consultant's approval.
- C. Qualified AV Contractors, listed in no particular order, are as follows:
1. Forté, 355 Inverness Drive S Unit 355-A, Englewood, CO 80112, 303-792-4800.
  2. Ford Audio Video Systems, 4230 Carson Street, Denver CO 80239, 720-374-2345.
  3. Linx Multimedia, 9900 E 51st Avenue, Denver CO 80238, 303-574-1552.
  4. AVI-SPL 8560 Upland Drive, Suite 500, Englewood, CO 80112, 303-792-3090.

- D. Minimum Performance Requirements: To meet the minimum performance requirements, the AV Contractor shall be responsible for:
  - 1. Each component's conformance with the manufacturer's published specifications and other requirements as stated herein.
  - 2. Detailed checking of each item of equipment provided for each portion of the installation, and of the complete installation to find and remedy any defects therein.
  - 3. Setting the system gain structure, including initial adjustment of digital signal processing, and amplifier gain controls and, under the direction of the Consultant, making the final adjustment of these items.
  - 4. Alignment and focus of video displays adjusting for optimized settings. Under the direction of the Consultant, if required, make final adjustments to the displays and associated video processing equipment.
  - 5. Adjusting/applying EDID management strategy and adjusting color space for all displays in order to display the most optimal image possible for each video source.
- E. Final Acceptance:
  - 1. Final acceptance shall be contingent upon issuance by the Consultant of a letter of acceptance stating that the work has been completed and is in accordance with the contract documents.
- F. Manufacturers' Qualifications:
  - 1. All electronic products shall be designed and marketed by the manufacturer for application in professional video projection, sound amplifying, reproduction and recording systems.
  - 2. All products proposed by the AV Contractor for use in the systems described herein are subject to approval by the Consultant.

## 1.10 SUBMITTALS

- A. Submittals shall be in accordance with Division 01 requirements.
- B. Prior to bidding, submit the following:
  - 1. AV Contractor Qualification Statement: Non-pre-qualified AV Contractors shall submit electronic media in PDF format containing a statement of the AV Contractor's qualifications for approval.
  - 2. As a minimum, this submittal shall include the following:
    - a. A list of AV systems of comparable size and scope to that described herein, completed by the AV Contractor in the last five (5) years. Show project name and address, year of completion and the name, telephone number, and e-mail address of a person to contact who is a representative of the Owner or User.
    - b. A personal resume of formal education and experience of the qualified staff engineer who would direct the work.
    - c. A personal resume of the staff member(s) with the required manufacturer certification and control system programming qualifications.
    - d. A description of the AV Contractor's capabilities and facilities for rack assembly, shop fabrication, software programming, repair and servicing of AV systems.
    - e. A letter from the processor and control system manufacturer(s) certifying that the AV Contractor's software programmers have been factory trained and are qualified to provide the proposed installation.

- C. After the contract has been awarded, but before product procurement or installation begins, submit the following:
1. Shop Drawings: The shop drawings shall be submitted after award of contract and be of a scale suitable for fabrication. Contractor shall make the following shop drawing submittals. All drawings, equipment schedule, and equipment specifications must be included in a single package but have individual PDFs for each submittal listed below.
    - a. A schedule of equipment to be provided for the systems with quantities, including that required for items which are to be fabricated by the AV Contractor. Include cable, connectors, and items which are to be custom fabricated. Do not include extraneous information or products which are not to be used in the project. Schedule of equipment must include quantities and locations of devices.
    - b. A set of manufacturer's equipment specifications with detailed technical information describing and illustrating all components and materials to be used in the installation of the AV systems. This includes those items listed by manufacturer and model number in Paragraph 2.3 and any other components needed to provide complete functional systems. Where a manufacturer provides a specification sheet with multiple products or options, highlight the product and options to be provided.
    - c. A set of drawings showing items which are to be fabricated by the AV Contractor including, but not limited to, custom panels and receptacle plates. Drawings shall show materials, finishes and panel/control markings when applicable. Custom panels and receptacle plates shall be manufactured only by approved manufacturers. Typical drawings are only acceptable for identical items. Similar items with different markings shall be submitted separately.
    - d. A set of drawings including, but not limited to, floor plans, reflected ceiling plans, elevations, and sections detailing the layout and location of equipment. Show equipment to scale and include manufacturer and model numbers on drawings. Include required equipment clearances, projection beam paths, camera fields of view, device aiming, orientation and, details showing any AV equipment integrated into furniture, and loudspeaker tap settings on reflected ceiling plans.
    - e. A set of one-line block diagrams showing exactly the manner in which the AV Contractor proposes to install the systems. Show all switches, modifications to equipment, relay and control circuits. Show all equipment/apparatus items which are required for realization of the functions described herein. Label each item with manufacturer and model number. Provide wire tags for all connections including wire number, signal type, wire manufacturer and model, and connectors. Show wire numbers as they will be displayed in the field.
    - f. Detailed diagrams showing equipment rack layouts. Show equipment manufacturer, model number, electrical loads, electrical power circuit numbers, heat loads, and electrical power sequencing for all equipment. Provide rear views of racks with rear facing equipment. Provide text for custom lamacoid equipment labels.
    - g. Detailed diagrams showing audio patch panel layouts. Show connected equipment input and output labels. Show all normal connections including the type of normal
    - h. Detailed drawings of custom millwork and technical furniture to be provided by the Contractor, including but not limited to mix position desks and lecterns. Show all conduit, boxes, and coordination with other trades.
    - i. Equipment mounting details showing all video displays, loudspeakers, projection screens, and other equipment requiring mounting or suspension. Show all hardware identified by manufacturer and model number. All rigging, overhead suspension, and



mounting shall be reviewed and stamped by a structural engineer licensed in the state where the Work is to be performed.

j. Any items listed as “submit for review” in Paragraph 2.3 herein.

D. After the installation of infrastructure is complete but before the installation of AV equipment, submit the following:

1. RF Coordination & RF Remote Antenna Cable Report. Provide a report including the following:
  - a. Provide the operating frequencies of all AV wireless equipment. Provide the output of intermodulation analysis software showing that the selected frequencies will be free from intermodulation interference as well as external interference documented in the FCC database.
  - b. Use an RF scanner used on site to determine if interference sources not in the FCC database are present in the selected frequency bands. Document the results in the report.
  - c. Provide the measured length of RF cable runs to all remote antennas.
  - d. Provide the wireless equipment manufacturer recommended cable RG type for each run.
  - e. Provide the proposed cable to be installed, including manufacturer and model number.
  - f. Provide the attenuation in dB/100ft at the worst-case frequency used by the antenna. Where required, interpolate cable manufacturer provided attenuation data.
  - g. Calculate the signal attenuation of each remote antenna RF cable run and provide the results. Attenuation should not exceed 3dB. If calculated attenuation is greater than 3 dB, select a lower loss cable and perform the calculations again. See Paragraph 2.5 for acceptable cable. If the calculated attenuation is too high using the best specified cable, provide an amplifier to make up for signal loss, but avoid over-amplifying the signal.
2. Control System Submittal
  - a. Prior to beginning any programming coordinate with the Owner and Consultant on general expectations.
  - b. Conduct a programming discovery meeting with the Owner to review the following:
    - 1) General overall layout.
    - 2) Color palette.
    - 3) Expected control functions by room.
    - 4) Organization of basic and advanced functions.
    - 5) Detailed expectations for advanced control of individual components or subsystems.
    - 6) Expectations for automated or grouped control functions.
    - 7) Any other control-related functionality as required by the Owner.
  - c. Provide a minimum of three (3) programming submittals with four (4) revisions to the Owner and Consultant as follows:
    - 1) The first submittal shall be comprised of a list of functions to be provided by the space. One revision shall be made after comment.
    - 2) The second submittal shall be comprised of working touch panel screen shots provided by room. One revision shall be made after comment.

- 3) The third submittal shall be comprised of working touch panels of each type and loaded with each room's specific programming. The Owner shall be able to operate the panel and navigate to all pages but will not be able to control any equipment. One revision shall be made after comment.
  - 4) The system shall be reviewed again with the Owner when fully functioning during the initial Consultant post-construction visit. One revision shall be made after comment.
- E. During installation but before system testing, submit the following:
1. Digital Signal Processor Configuration Files:
    - a. Complete digital signal processor files provided in the DSP manufacturer's file format.
- F. After submittals have been approved but before the initial post-construction Consultant site visit, submit the following:
1. Testing Report. Provide a report documenting the results of system tests described herein. The Consultant will not schedule the initial post-construction site visit until this report has been delivered.
- G. After the initial post-construction Consultant site visit, submit the following:
1. A signed copy of the initial post-construction Consultant site visit punch list with each completed item initialed. The Consultant will not schedule the final post-construction or visit until this document has been delivered.
- H. After the final Consultant site visit and final punch list has been completed, submit the following:
1. Operation Manual: Provide the following in a neatly bound binder with tabbed dividers between sections. Also, provide a digital copy in PDF format on a USB solid state memory drive.
    - a. Title Page
    - b. Table of Contents
    - c. Description of each system including key features and operational concepts.
    - d. Setup diagrams and instructions to use in typical situations as directed by the Owner.
    - e. Single-line block diagrams showing all major system components.
    - f. Manufacturer's operation manuals and information sheets for equipment intended for operation by system users.
    - g. A sheet of web links to relevant industry resources such as:
      - 1) The Shure publication Microphone Techniques for Live Sound Reinforcement.
      - 2) The Soundcraft Guide to Mixing.
      - 3) The Electro-Voice PA Bible including Introduction, PA Bible, and Additions two, three, four, five, seven, eight, nine, fourteen, and twenty.
    - h. Key schedule cross-referencing all keys to their respective functions and extra copies of all keys required to open or operate equipment specified in this section.
  2. Maintenance Manual: Provide the following in a neatly bound binder with tabbed dividers between sections. Also, provide a digital copy in PDF format on a CD-ROM or USB solid state memory drive.
    - a. Title Sheet
    - b. Table of Contents

- c. Company name, address, telephone number, e-mail address, website, and contact name for system service or maintenance.
  - d. List of all equipment and materials with names of manufacturers and model numbers or part numbers.
  - e. Product manufacturer's warranties and a typed one-year system warranty explicitly covering all materials and labor.
  - f. Manufacturer's service manuals for all major equipment items.
  - g. A recommended preventative maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where the manufacturer provides inadequate information, provide the information necessary for proper maintenance.
  - h. Provide a working copy of the latest version of all software required to operate or configure the systems specified herein.
  - i. All software shall be fully documented, and that documentation included.
  - j. Software shall be furnished on a CD-ROM or USB solid state memory drive attached to the binder.
  - k. All user definable software configurations and/or programming shall become the sole property of the Owner. This includes all source code, source code copyrights, and related documentation.
- 3. Training Materials as described herein.
  - 4. As-Built Drawings:
    - a. Maintain a full set of shop drawings at the project site marked up to indicate actual locations of equipment, boxes, and other items called for in this section. After the final Consultant site visit, compile the mark-ups into an electronic set of as-built drawings in AutoCAD or Revit and provide to the General Contractor, Architect, and Consultant.

## 1.11 WARRANTY

- A. Provide a written one (1) year warranty, signed by the Contractor, due on the date of final acceptance.
- B. Include the following provisions:
  - 1. Warranty all equipment and the installation to be free of faulty workmanship.
  - 2. Warranty all components and materials to be free of defects for a period of one (1) year from the date of final acceptance.
  - 3. Paint and exterior finishes, fuses and lamps are excluded from the above warranty, except when damage or failure results from defective materials or workmanship covered by the warranty.

## 1.12 SERVICE WARRANTY

- A. Replace defective materials and repair faulty workmanship within forty-eight (48) hours of discovery at no cost to the Owner during the period of the warranty.
- B. The Contractor shall be available on call and on eight (8) hour notice during the first month following acceptance of the system, to assist the Owner's representatives in any problems which may arise during the initial period of operation.
- C. At no additional charge, provide maintenance service for a period of one (1) year after final acceptance of installation. This service shall consist of at least one visit at six months and one visit at eleven months after final acceptance for checking the equipment and making any necessary adjustments.
- D. If, during the warranty period, any component is out of service for more than seven (7) days due to unavailability of parts or service, supply and install an identical new component. If an identical component is not available, substitute equivalent equipment, but only with the approval of the Owner.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. All materials, equipment and apparatus shall be new and of the latest design or model offered for sale by the manufacturer.
- B. Principal items of equipment and apparatus are identified herein by part number and manufacturer. Alternate part numbers and manufacturers are identified in instances in which equivalence has been determined.
- C. For all items which are identified by part number and manufacturer, performance specifications which are published in the most recent manufacturer's data sheets available at the time of bidding this contract shall be applicable to the present work as though fully written out herein.
- D. For those items which are not identified by part number and manufacturer, the AV Contractor may select items which conform to the functional and/or technical specifications. For all such items, the AV Contractor shall submit exact make and model for approval including all technical data which is available from the supplier or manufacturer.
- E. All AV equipment with standard color selections shall be coordinated with the Owner and Architect before submission of shop drawings and ordering.

### 2.02 EQUIVALENT EQUIPMENT

- A. All equipment listed by make/model in Paragraph 2.3 represents a minimum standard of performance based on specifications supplied by the manufacturer. All equipment substitutions shall be submitted to the Consultant for review and approval prior to bid. It is the responsibility of the AV Contractor to prove that requested substitutions are equivalent to the specified product and compatible with the overall system design, intent, and electrical infrastructure. If requested by the Consultant, the AV Contractor shall submit a sample of any proposed substitutions.
- B. Any and all deficiencies in the functionality and performance of substituted equipment shall remain the sole responsibility of the Contractor requesting the substitution and the AV Contractor shall provide any necessary equipment accessories as may be necessary to satisfy the functionality or performance of the originally specified equipment.

## 2.03 EQUIPMENT:

| DESCRIPTION                                 | MANUFACTURER | MODEL NUMBER | QTY (BASE) |
|---------------------------------------------|--------------|--------------|------------|
| <b>AUDIO DEVICES</b>                        |              |              |            |
| Wireless Microphone Antennas                | Shure        | UA874        | 2          |
| Wireless Microphone Antenna Signal Splitter | Shure        | UA221        | 2          |
|                                             |              |              |            |
| Wireless Microphone Receiver                | Shure        | ANX4         | 2          |
| w/ 4-Channel License                        | Shure        | ANX4-4CL     | 8          |
| w/ Handheld Transmitter                     | Shure        | ULXD2/B87C   | 8          |
| w/ Bodypack Transmitter                     | Shure        | ULXD1        | 32         |
| w/ Over Ear Microphone                      | Shure        | MX153        | 36         |
| w/ Lavalier Microphone                      | Shure        | WL185        | 20         |
|                                             |              |              |            |
| Room Microphone                             | Sennheiser   | MKH 418-S    | 1          |
| w / Mount                                   | Custom       | As Required  | 1          |
|                                             |              |              |            |
| Wired Vocal Microphones                     | Shure        | SM58         | 6          |
|                                             |              |              |            |
| Wired Instrument Microphones                | Shure        | SM57         | 4          |
|                                             |              |              |            |
| Drum Microphone Kit                         | Shure        | DMK57-52     | 1          |
|                                             |              |              |            |
| Choir Microphones                           | Audix        | ADX40        | 6          |
| w/ Microphone Stand Adapters                | Audix        | MC-MICRO     | 6          |
|                                             |              |              |            |
| Lectern Microphone                          | Shure        | MX415/C      | 1          |
|                                             |              |              |            |
| Wired Condenser Microphones                 | MXL          | 603 pair     | 1          |
|                                             |              |              |            |
| Instrument DI Boxes                         | Radial       | ProDI        | 4          |
| AV DI Box                                   | Radial       | ProAV2       | 2          |
| USB DI Box                                  | Radial       | USB PRO      | 1          |
|                                             |              |              |            |
| Stage Manager's Paging Microphone           | AKG          | DGN99 E      | 1          |
| w/ Panel Mount                              | Custom       | As Required  | 1          |
| w/ Momentary Button Switch                  | RDL          | AMS-PB1      | 1          |
|                                             |              |              |            |
| Microphone Cables (6')                      | Custom       | Custom       | 4          |
| Microphone Cables (10')                     | Custom       | Custom       | 8          |
| Microphone Cables (25')                     | Custom       | Custom       | 16         |
| Microphone Cables (50')                     | Custom       | Custom       | 4          |
| Microphone Cables (100')                    | Custom       | Custom       | 2          |
|                                             |              |              |            |
| Microphone Stand                            | On-Stage     | MS7701B      | 8          |

| DESCRIPTION                                                                      | MANUFACTURER  | MODEL NUMBER   | QTY (BASE) |
|----------------------------------------------------------------------------------|---------------|----------------|------------|
| Short Microphone Stand                                                           | On-Stage      | MS7311B        | 4          |
| Kick Drum Microphone Stand                                                       | On-Stage      | MS7411B        | 2          |
| Theatre Digital Mixing Console                                                   | Allen & Heath | SQ-7+          | 1          |
| w/ 64x64 Dante Expansion Card                                                    | Allen & Heath | SQ Dante 64x64 | 1          |
| Digital Snake Head 1                                                             | Allen & Heath | GX4816         | 1          |
| w/ Digital Snake A/B Network Switch Including Latching Relay and Network Control | L-Com         | LC-SNSW-C6-LEC | 1          |
| Digital Snake Expander - House Mix Position                                      | Allen & Heath | DX88P          | 1          |
| w/ Rackmount Kit                                                                 | Allen & Heath | DX88-P-RK19    | 1          |
| Digital Snake Expander - Control Room Mix Position                               | Allen & Heath | DX88P          | 1          |
| w/ Rackmount Kit                                                                 | Allen & Heath | DX88-P-RK19    | 1          |
| Portable Snake Head with Dante                                                   | Allen & Heath | DT168          | 1          |
| Stage Manager's Consumer Input                                                   | RDL           | DB-CIJ3D       | 1          |
| Mix Position Media Player                                                        | Tascam        | CD-400U        | 1          |
| Mix Position Recorder                                                            | Tascam        | SS-R250N       | 1          |
| Control Room Mix Position Consumer Input                                         | RDL           | DB-CIJ3D       | 1          |
| House Mix Position Consumer Input                                                | RDL           | DB-CIJ3D       | 1          |
| Digital Signal Processor Including Required Licenses and Accessories             | QSC           | Core 24f       | 1          |
| Digital Signal Processor Expander                                                | QSC           | QIO-24f        | 1          |
| Power Amplifier 1 - Main High                                                    | Dynacord      | C1800FDi       | 1          |
| Power Amplifier 2 - Main Low                                                     | Dynacord      | C2800FDi       | 1          |
| Power Amplifier 3 - Subwoofer                                                    | Dynacord      | C3600FDi       | 1          |
| Power Amplifier 4 - Delay High                                                   | Dynacord      | C1800FDi       | 1          |
| Power Amplifier 5 - Delay Low                                                    | Dynacord      | C2800FDi       | 1          |
| Power Amplifier 6 - Back of House                                                | QSC           | CX-Q 4K4       | 1          |
| Line-Level Monitor Distribution Amplifier                                        | RDL           | RUAD8D         | 1          |

| DESCRIPTION                                    | MANUFACTURER                                                                                                           | MODEL NUMBER      | QTY (BASE) |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-------------------|------------|
| Main Left Near, Main Right Near Loudspeakers   | EV                                                                                                                     | EVF-12/66-B       | 2          |
| w/ Rigging                                     | Custom                                                                                                                 | Submit for Review | AR         |
|                                                |                                                                                                                        |                   |            |
| Main Center Loudspeaker                        | EV                                                                                                                     | EVH-15/95-B       | 1          |
| w/ Rigging                                     | Custom                                                                                                                 | Submit for Review | AR         |
|                                                |                                                                                                                        |                   |            |
| Main Subwoofer                                 | EV                                                                                                                     | EVF-215S-B        | 2          |
| w/ Rigging Hardware                            | Custom                                                                                                                 | Submit for Review | AR         |
|                                                |                                                                                                                        |                   |            |
| Delay Loudspeakers                             | EV                                                                                                                     | EVF-12/99-B       | 3          |
| w/ Rigging                                     | Custom                                                                                                                 | Submit for Review | AR         |
|                                                |                                                                                                                        |                   |            |
| Back Of House and Control Room Volume Controls | AtlasIED                                                                                                               | AT100             | 5          |
| Back Of House Ceiling Speakers                 | EV                                                                                                                     | C6.2              | 8          |
| Scene Shop Surface Mount Speakers              | EV                                                                                                                     | EVID-S5.2T        | 2          |
| Control Room Surface Mount Speakers            | EV                                                                                                                     | EVID-S5.2T        | 2          |
|                                                |                                                                                                                        |                   |            |
| 12" Powered Portable Monitor Loudspeakers      | Electro-Voice                                                                                                          | PXM-12MP-US       | 4          |
| w/ Protective Cover                            | Electro-Voice                                                                                                          | PXM-12M-CVR       | 4          |
| w/ Loudspeaker Stands                          | Ultimate                                                                                                               | TS-90B            | 4          |
| w/ 25' Power and Signal Combo Cable            | Elite Core                                                                                                             | PA25              | 4          |
| w/ 50' Power and Signal Combo Cable            | Elite Core                                                                                                             | PA50              | 4          |
|                                                |                                                                                                                        |                   |            |
| Assisted Listening Transmitter Kit w/ Signage  | WilliamsAV                                                                                                             | FM T55            | 1          |
| w/ Rack Mount Kit                              | WilliamsAV                                                                                                             | RPK 005           | 1          |
| w/ Remote ALS Antenna                          | WilliamsAV                                                                                                             | ANT 029           | 1          |
| w/ Receiver                                    | WilliamsAV                                                                                                             | PPA R38N          | AR         |
| w/ Ear Speakers                                | WilliamsAV                                                                                                             | EAR 022           | AR         |
| w/ Telecoil Neckloop                           | WilliamsAV                                                                                                             | NKL 001           | AR         |
| w/ Charger                                     | WilliamsAV                                                                                                             | CHG 3512          | AR         |
|                                                | AV Contractor to confirm and provide quantities of ALS receivers and accessories required by current applicable codes. |                   |            |
| <b>VIDEO DEVICES</b>                           |                                                                                                                        |                   |            |
| Stage Manager's Video Encoder                  | Crestron                                                                                                               | DM-NVX-E30        | 1          |
|                                                |                                                                                                                        |                   |            |
| Stage Manager's Blu-Ray Player                 | Tascam                                                                                                                 | BD-MP4K           | 1          |
| w/ Video Encoder                               | Crestron                                                                                                               | DM-NVX-E30        | 1          |
|                                                |                                                                                                                        |                   |            |
| House Mix Position Video Encoder               | Crestron                                                                                                               | DM-NVX-E30        | 1          |
|                                                |                                                                                                                        |                   |            |
| Control Room Mix Position Video Encoder        | Crestron                                                                                                               | DM-NVX-E30        | 1          |



| DESCRIPTION                                                                                                                | MANUFACTURER   | MODEL NUMBER | QTY (BASE) |
|----------------------------------------------------------------------------------------------------------------------------|----------------|--------------|------------|
| Point of View PTZ Camera                                                                                                   | Panasonic      | AW-UE100     | 1          |
| w/ Wall Mount                                                                                                              | Nigel B Design | NB-AVCB-W    | 1          |
| w/ 4K Fiber HDMI Cable - Field Verify Length                                                                               | Covid          | P-HDA20-XXX  | 1          |
| w/ PTZ Camera Video Encoder                                                                                                | Crestron       | DM-NVX-E30   | 1          |
|                                                                                                                            |                |              |            |
| Floor Box Video Encoder                                                                                                    | Crestron       | DM-NVX-E30   | 1          |
| w/ 4K Fiber HDMI Cable - Field Verify Length                                                                               | Covid          | P-HDA20-XXX  | 1          |
|                                                                                                                            |                |              |            |
| Portable Video Encoder                                                                                                     | Crestron       | DM-NVX-E30   | 2          |
|                                                                                                                            |                |              |            |
| Single Channel Streaming Appliance                                                                                         | Extron         | SMP 111      | 1          |
| w/ Rack Mount Kit                                                                                                          | Extron         | HRU 109      | 1          |
| w/ Video Decoder                                                                                                           | Crestron       | DN-NVX-D30   | 1          |
|                                                                                                                            |                |              |            |
| Theatre Projector, WUXGA Laser, 20,000 Lumens                                                                              | Epson          | EB-PU2220B   | 1          |
| w/ 1.57-2.56:1 Zoom Lens (Verify in Field)                                                                                 | Epson          | ELPLM11      | 1          |
| w/ Network Video Decoder                                                                                                   | Crestron       | DM-NVX-D30   | 1          |
| w/ Ceiling Mount                                                                                                           | Chief          | VCMU         | 1          |
| w/ Ceiling Mount Accessories                                                                                               | Chief          | CMA Series   | AR         |
|                                                                                                                            |                |              |            |
| 335" (124" x 198") Motorized Tab Tensioned Projection Screen with Low Voltage Controller and Premium Contrast Grey Surface | Draper         | 114619TD     | 1          |
|                                                                                                                            |                |              |            |
| Scenic Projector                                                                                                           | Epson          | EB-PU2220B   | 2          |
| w/ Ultra Short Throw Lens Including Required Components                                                                    | Epson          | ELPLX02S     | 2          |
| w/ Network Video Decoder                                                                                                   | Crestron       | DM-NVX-384   | 2          |
| w/ Mount Including Required Accessories                                                                                    | Chief          | VCMU         | 2          |
| w/ Truss Clamp                                                                                                             | Chief          | CMS380       | 2          |
| w/ Compatible Alignment Camera Including Required Licenses and Accessories                                                 | Epson          | ELPEC01      | 2          |
|                                                                                                                            |                |              |            |
| Stage Confidence Monitors                                                                                                  | Panasonic      | TH-65CQ      | 2          |
| w/ Video Decoder                                                                                                           | Crestron       | DM-NVX-D30   | 2          |
| w/ Large In-Wall Storage Box                                                                                               | Chief          | PAC526       | 2          |
| w/ Swing Wall Mount                                                                                                        | Chief          | PNRUB        | 2          |
|                                                                                                                            |                |              |            |
| Stage Manager's Rackmount Video Monitor                                                                                    | ToteVision     | LED-1562HDR  | 1          |
| w/ Video Decoder                                                                                                           | Crestron       | DM-NVX-D30   | 1          |

| DESCRIPTION                                                                 | MANUFACTURER                                                                                                                        | MODEL NUMBER   | QTY (BASE) |
|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------|------------|
| Dressing Room Monitor                                                       | Panasonic                                                                                                                           | TH-43CQ        | 2          |
| w/ Video Decoder                                                            | Crestron                                                                                                                            | DM-NVX-D30     | 2          |
| w/ In-Wall Storage Box                                                      | Chief                                                                                                                               | PAC526         | 2          |
| w/ Tilting Wall Mount                                                       | Chief                                                                                                                               | MTA1U          | 2          |
|                                                                             |                                                                                                                                     |                |            |
| Network Video Decoder - Vocal, Band, Orchestra Rooms                        | Crestron                                                                                                                            | DM-NVX-D30     | 3          |
|                                                                             |                                                                                                                                     |                |            |
| 10' HDMI Presentation Cables for Portable Devices                           | Atlona                                                                                                                              | LC-H2H-2M      | 6          |
| <b>CONTROL DEVICES</b>                                                      |                                                                                                                                     |                |            |
| Stage Manager's Rack 10" Touchscreen                                        | Crestron                                                                                                                            | TSW-1070       | 1          |
| w/ Rack Mount                                                               | Crestron                                                                                                                            | TSW-1070-RMK-2 | 1          |
|                                                                             |                                                                                                                                     |                |            |
| Mix Position 10" Tabletop Touchscreen (House Mix & Control Room)            | Crestron                                                                                                                            | TS-1070        | 2          |
|                                                                             |                                                                                                                                     |                |            |
| Central Controller                                                          | Crestron                                                                                                                            | CP4            | 1          |
|                                                                             |                                                                                                                                     |                |            |
| 44x1G POE++ and 4xSFP Managed Network Switch                                | Netgear or Equal                                                                                                                    | XSM4344C*      | 2          |
| Complete With All Necessary Licenses and Accessories                        | *Coordinate exact network switches with owner IT and DSP, Network Video, and control manufacturers before ordering network switches |                |            |
|                                                                             |                                                                                                                                     |                |            |
| Scenic Projector Calibration PC - Confirm Calibration Software Requirements | BSI                                                                                                                                 | RMS110         | 1          |
| w/ Rack-Mount Keyboard with Touchpad                                        | Tripp Lite                                                                                                                          | SRSHELFKBD     | 1          |
| w/ Image Alignment Software Including Required Licenses                     | Epson                                                                                                                               | PJ Pro Tool    | 1          |
|                                                                             |                                                                                                                                     |                |            |
| <b>INTERCOM DEVICES</b>                                                     |                                                                                                                                     |                |            |
| Intercom Base Station                                                       | Clear-Com                                                                                                                           | MS-702         | 1          |
|                                                                             |                                                                                                                                     |                |            |
| Intercom Speaker Stations                                                   | Clear-Com                                                                                                                           | KB-701         | 7          |
|                                                                             |                                                                                                                                     |                |            |
| Dual-Channel Intercom Belt Pack                                             | Clear-Com                                                                                                                           | RS-702         | 3          |
| w/ Intercom Headset                                                         | Clear-Com                                                                                                                           | CC-300         | 3          |
| w/ 10' 6-Pin Cable                                                          | Whirlwind                                                                                                                           | MK6CC010       | 4          |
| w/ 25' 6-Pin Cable                                                          | Clear-Com                                                                                                                           | MK6CC025       | 2          |
|                                                                             |                                                                                                                                     |                |            |
| Single-Channel Intercom Belt Pack                                           | Clear-Com                                                                                                                           | RS-701         | 9          |
| w/ Intercom Headset                                                         | Clear-Com                                                                                                                           | CC-300         | 9          |
| w/ 10' 3-Pin Clear-Com Cable                                                | Clear-Com                                                                                                                           | MK410          | 10         |
| w/ 25' 3-Pin Clear-Com Cable                                                | Clear-Com                                                                                                                           | MK425          | 4          |

| DESCRIPTION                                                                           | MANUFACTURER    | MODEL NUMBER      | QTY (BASE) |
|---------------------------------------------------------------------------------------|-----------------|-------------------|------------|
| Intercom Breakout Cable 6 pin to (2) 3-pin                                            | Clear-Com       | YC-36             | 2          |
|                                                                                       |                 |                   |            |
| <b>SUPPORT EQUIPMENT</b>                                                              |                 |                   |            |
| Stage Manager's Rack (AV RK-1)                                                        | Middle Atlantic | SR-40-28          | 1          |
| w/ ID Panel                                                                           | Custom          | Custom            | 1          |
| w/ Cable management, rear door, blank panels, hardware, and all necessary accessories | Middle Atlantic | As Required       | AR         |
| w/ Vented Front Door                                                                  | Middle Atlantic | VFD-40            | 1          |
| w/ Power distribution, Power Sequencing, and Surge Protection                         | Middle Atlantic | MPR Series        | AR         |
| w/ Utility Drawer                                                                     | Middle Atlantic | UD2               | 2          |
| w/ Brush Grommet Panel                                                                | Middle Atlantic | BR1               | 1          |
| w/ UPS                                                                                | Middle Atlantic | UPX-1000R-2       | 1          |
|                                                                                       |                 |                   |            |
| Amplifier Rack (AV RK-2)                                                              | Middle Atlantic | ERK-4428          | 2          |
| w/ Cable management, blank panels, hardware, and all necessary accessories            | Middle Atlantic | As Required       | AR         |
| w/ Vented Front Door                                                                  | Middle Atlantic | LVFD-44           | 2          |
| w/ Fan Top Kit & Thermostat                                                           | Middle Atlantic | Submit for Review | AR         |
| w/ Power distribution, Power Sequencing, and Surge Protection                         | Middle Atlantic | MPR Series        | AR         |
| w/ ID Panel                                                                           | Custom          | Custom            | 1          |
| w/ Utility Drawer                                                                     | Middle Atlantic | UD4               | 1          |
| w/ Brush Grommet Panel                                                                | Middle Atlantic | BR1               | 2          |
| w/ UPS                                                                                | Middle Atlantic | UPX-S2200R        | 1          |
|                                                                                       |                 |                   |            |
| House Mix Position Locking Rolltop Desk with Rack (AV RK-3)                           | HSA             | Drawing # 26038   | 1          |
| w/ ID Panel                                                                           | Custom          | Custom            | 1          |
| w/ Cable management, blank panels, hardware, and all necessary accessories            | Middle Atlantic | As Required       | AR         |
| w/ Sliding Shelf                                                                      | Middle Atlantic | SS                | 1          |
| w/ Utility Drawer                                                                     | Middle Atlantic | UD2               | 1          |
| w/ Desktop Power Strip                                                                | Middle Atlantic | PDT-620C-NS       | 2          |
| w/ Desktop Box                                                                        | FSR             | DSKB-3G           | 1          |
| w/ UPS                                                                                | Middle Atlantic | UPS-S1000R        | 1          |
|                                                                                       |                 |                   |            |
| Control Room Mix Position Under-Counter Rack (AV RK-4)                                | Middle Atlantic | ERK-1025KD        | 1          |
| w/ Cable management, blank panels, hardware, and all necessary accessories            | Middle Atlantic | As Required       | AR         |
| w/ Caster Base                                                                        | Middle Atlantic | CBS-ERK-25        | 1          |
| w/ Utility Drawer                                                                     | Middle Atlantic | UD2               | 1          |
| w/ Desktop Power Strip                                                                | Middle Atlantic | PDT-620C-NS       | 2          |
| w/ UPS                                                                                | Middle Atlantic | UPS-S1000R        | 1          |

| DESCRIPTION                                          | MANUFACTURER | MODEL NUMBER | QTY<br>(BASE) |
|------------------------------------------------------|--------------|--------------|---------------|
| Stage Floor Box                                      | FSR          | FL-600P-6-B  | 2             |
| w/ Cover - Submit for Review                         | FSR          | As Required  | 2             |
|                                                      |              |              |               |
| Cable, Connectors, Custom Plates,<br>Hardware, Misc. | Custom       | Custom       | AR            |
|                                                      |              |              |               |

## 2.04 EQUIPMENT PERFORMANCE SPECIFICATIONS

- A. The performance specifications for all components shall be as published in the most recent manufacturer's data sheets available at the time of bidding on this contract and shall be applicable to the present work as though fully given herein.

## 2.05 WIRING AND CONDUCTORS

- A. Installed microphone and line level cable:
1. Cable shall be 22 AWG stranded tinned copper, UL Listed, NEC Type CM CMR or CMP, PVC jacketed, twisted pair, with 100% coverage overall foil shield. Where required by code installed microphone and line level cables shall be plenum rated.
    - a. Approved non-plenum cables:
      - 1) Belden 8451, 9451 West Penn 77291
      - 2) Liberty 22-1P-EX
      - 3) Clark SPA22GS
      - 4) Submit proposed alternative for approval.
    - b. Approved plenum cables:
      - 1) Belden 9451P
      - 2) West Penn D25291
      - 3) Liberty 22-1P-CMP-EZ
      - 4) Clark SPA22GSP
      - 5) Submit proposed alternative for approval.
- B. Portable microphone, line level, and single channel analog party line intercom cable:
1. Cable shall be 20 AWG stranded tinned copper, EPDM Jacket, with minimum 85% coverage tinned copper braid shield.
    - a. Approved portable microphone cable:
      - 1) Belden 8412
      - 2) Clark FF220
      - 3) Submit proposed alternative for approval.

- C. Analog party line intercom systems cable:
1. Cable shall be 18 AWG stranded tinned copper, UL listed, NEC Type CM, CMR, or CMP, PVC jacketed, twisted pair, with 100% coverage overall foil shield. Where required by code, analog party line intercom system cables shall be plenum rated.
    - a. Approved non-plenum cables:
      - 1) Belden 8760
      - 2) West Penn 77293
      - 3) Clark SPA18GS
      - 4) Submit proposed alternative for approval.
    - b. Approved plenum cables:
      - 1) Belden 88760
      - 2) West Penn D25293
      - 3) Clark SPA18GSP
      - 4) Submit proposed alternative for approval.
- D. Loudspeaker cable for high impedance (70V) systems:
1. Cable shall be copper 14 AWG, UL Listed, NEC Type CL3 or CL3P, PVC jacketed, stranded conductor.
    - a. Approved non-plenum cables:
      - 1) Belden 8473
      - 2) West Penn 226
      - 3) Liberty 14-2C
      - 4) Clark CW1402
      - 5) Submit proposed alternative for approval.
    - b. Approved plenum cables:
      - 1) Belden 6100UE
      - 2) West Penn 25226B
      - 3) Liberty 14-2C-P
      - 4) Clark CW1402P
      - 5) Submit proposed alternative for approval.
- E. Loudspeaker cable for low impedance systems, runs less than 150', except 4-ohm dedicated low frequency loudspeakers (subwoofers):
1. Cable shall be copper 12 AWG, UL Listed, NEC Type CL3, PVC jacketed, stranded conductor.
    - a. Approved non-plenum cables:
      - 1) Belden 8477, 5000UE
      - 2) West Penn 227
      - 3) Liberty 12-2C
      - 4) Clark CW1202
      - 5) Submit proposed alternative for approval.

- b. Approved plenum cables:
      - 1) Belden 6000UE
      - 2) West Penn 25227B
      - 3) Liberty 12-2C-P
      - 4) Clark CW1202P
      - 5) Submit proposed alternative for approval.
- F. Loudspeaker cable for low impedance systems, runs greater than 150', and for all 4-Ohm dedicated low frequency loudspeakers (subwoofers):
  - 1. Cable shall be copper 10 AWG, UL Listed, NEC Type CL2, PVC jacketed, stranded conductor. Where required by code, loudspeaker cables shall be plenum rated.
    - a. Approved non-plenum loudspeaker cables:
      - 1) Belden 5T00UP
      - 2) West Penn HA210
      - 3) Clark CW1002
      - 4) Submit proposed alternative for approval.
    - b. Approved plenum loudspeaker cables:
      - 1) Belden 6T00UP
      - 2) West Penn 25210
      - 3) Clark CW1002P
      - 4) Submit proposed alternative for approval.
- G. Portable loudspeaker cable:
  - 1. Cable shall be 12 AWG, UL listed, NEC Type SJ, EPDM insulation, rubber jacket. Portable loudspeaker cables shall be two-conductor except where used to service bi-amplified loudspeakers, in which case cables shall be four-conductor.
    - a. Approved manufacturers:
      - 1) General Cable/Carol
      - 2) Rapco/Horizon SJ12/2
      - 3) Clark PWC-12/2-SJOOW
      - 4) Submit proposed alternative for approval.
- H. RF cable for 50Ω wireless microphone antennas and assisted listening antennas:
  - 1. Note: Before installing or ordering RF cable, submit wireless microphone cable report.
  - 2. Cable type (RG designation) shall be as specified by equipment manufacturer and dependent on cable length.
    - a. Approved non-plenum RF cables:
      - 1) Approved non-plenum RG58/U
        - (a) Belden 8262
        - (b) West Penn 812, 813
        - (c) Liberty RG58-CMR
        - (d) Clark RG58/U
        - (e) Submit proposed alternative for approval.

- 2) Approved non-plenum RG8/X:
    - (a) Belden 9258
    - (b) West Penn 807
    - (c) Clark RG8X
    - (d) Submit proposed alternative for approval.
  - 3) Approved non-plenum RG213/U:
    - (a) Belden 8267
    - (b) Clark RG213/U
    - (c) Submit proposed alternative for approval.
  - 4) Approved non-plenum RG8/U:
    - (a) Belden 9913
    - (b) West Penn 808F
    - (c) Liberty RG8-CMR
    - (d) Clark RF50LL
    - (e) Submit proposed alternative for approval.
  - 5) Approved plenum RG58/U:
    - (a) Belden 88240
    - (b) West Penn 25810
    - (c) Liberty RG58-CMP
    - (d) Clark RG58-PLEN
    - (e) Submit proposed alternative for approval.
  - 6) Approved RG8/U:
    - (a) Belden 89913
    - (b) Liberty RG8-CMP
    - (c) Clark RG8PL
    - (d) Submit proposed alternative for approval.
- I. RF cable for 75Ω assisted listening antennas:
1. Cable type (RG designation) shall be as specified by equipment manufacturer and dependent on cable length.
    - a. Approved non-plenum RF cables:
      - 1) Approved non-plenum RG59:
        - (a) Belden 1370R
        - (b) West Penn 815
        - (c) Submit proposed alternative for approval.
      - 2) Approved non-plenum RG6:
        - (a) Belden 1369R
        - (b) West Penn 806
        - (c) Submit proposed alternative for approval.
      - 3) Approved non-plenum RG59:
        - (a) Belden 1370P
        - (b) West Penn 25815
        - (c) Submit proposed alternative for approval.
      - 4) Approved non-plenum RG6:
        - (a) Belden 1369P
        - (b) West Penn 25806
        - (c) Submit proposed alternative for approval.

- J. Installed network audio/video cable:
  - 1. Cable shall be UL listed Cat 6A, F/UTP-foil shielded, four pair, 23AWG solid bare copper conductors as recommended by network video, control, and network audio manufacturers.
  - 2. Coordinate jacket color with Owner IT.
    - a. Approved non-plenum network audio/video cable:
      - 1) Belden 10GX62F
      - 2) Liberty 24-4P-L6ASH
      - 3) West Penn 4246AF
      - 4) Clark CN423C6AS
      - 5) Submit proposed alternative for review.
    - b. Approved plenum network audio/video cable:
      - 1) Belden 10GX63F
      - 2) Liberty 24-4P-P-L6ASH
      - 3) West Penn 254246AF
      - 4) Clark CN423C6ASP-6
      - 5) Submit proposed alternative for review.

## 2.06 CONNECTORS

- A. The chassis connector shell color must match panel color when possible. Otherwise, the connector shell color shall be black.
- B. 3-Pin XLR connectors:
  - 1. 3-pin XLR cable connectors shall be 3-pole XLR type connectors, with solder cups and gold contacts.
    - a. Approved 3-Pin XLR cable connectors:
      - 1) Neutrik NC3FXX, NC3MXX
      - 2) Submit proposed alternative for approval.
    - b. Approved 3-Pin XLR chassis connectors:
      - 1) Neutrik NC3FD-L, NC3MD-L
      - 2) Submit proposed alternative for approval.
- C. 4-Pin XLR connectors:
  - 1. 4-pin XLR cable connectors shall be 4-pole XLR type connectors, with solder cups, with black metal housing, and with gold contacts.
    - a. Approved 4-Pin XLR cable connectors:
      - 1) Neutrik NC4FXX, NC4MXX
      - 2) Submit proposed alternative for approval.
    - b. Approved 4-Pin XLR chassis connectors:
      - 1) Neutrik NC4FD-L, NC4MD-L
      - 2) Submit proposed alternative for approval.



D. 5-Pin XLR connectors:

1. 5-pin XLR cable connectors shall be 5-pole XLR type connectors, with solder cups, with black metal housing, and with gold contacts.
  - a. Approved 5-Pin XLR connectors:
    - 1) Neutrik NC5FXX, NC5MXX
    - 2) Submit proposed alternative for review.
  - b. Approved 5-Pin XLR chassis connectors:
    - 1) Neutrik NC5FD, NC5MD
    - 2) Submit proposed alternative for review.

E. 6-Pin XLR connectors:

1. 6-pin XLR cable connectors shall be 6-pole XLR type connectors, with solder cups, with black metal housing, and with gold contacts.
2. Note: 6-Pin XLR connectors shall use the "Switchcraft Style" pinout to correctly interface with Clear-Com equipment.
  - a. Approved 6-Pin XLR connectors:
    - 1) Neutrik NC6FSXX, NC6MSXX
    - 2) Submit proposed alternative for review.
  - b. Approved 6-Pin XLR chassis connectors:
    - 1) Neutrik NC6FSD-L-1, NC6MSD-L-1
    - 2) Submit proposed alternative for review.

F. speakON connectors:

1. speakON cable connectors shall be four-pole, with chuck type strain relief, screw terminals, rated for 30A.
2. speakON panel connectors shall be four-pole, D-sized, with 3/16" flat tabs, rated for 30A.
  - a. Approved speakON cable connectors:
    - 1) Neutrik NL4FXX
    - 2) Submit proposed alternative for approval.
  - b. Approved speakON chassis connectors:
    - 1) Neutrik NL4MPXX
    - 2) Submit proposed alternative for approval.

G. RCA connectors:

1. RCA cable connectors shall be two pole RCA type, with nickel body, with nickel contacts, with solder cups, and with cable clamp.
  - a. Approved RCA cable connectors:
    - 1) Neutrik NYS352
    - 2) Switchcraft 3502A
    - 3) Canare F09, F10
    - 4) Submit proposed alternative for approval.

- b. Approved RCA chassis connectors (D sized connector):
      - 1) Neutrik NF2D
      - 2) Canare RJ-RUD
      - 3) Submit proposed alternative for review.
    - c. Approved RCA chassis connectors (panel mount):
      - 1) Neutrik NYS367
      - 2) Switchcraft 3501FPX
      - 3) Canare RJ-R
      - 4) Submit proposed alternative for review.
  - H. 1/8" mini (3.5mm) TRS connectors:
    - 1. 1/8" mini cable connectors shall be three-pole, with black body, with gold contacts, with solder cups, and with cable clamp.
      - a. Approved 1/8" mini straight connectors:
        - 1) Neutrik NYS231BG
        - 2) Switchcraft 35HDBAU
        - 3) Canare F-12
        - 4) Submit proposed alternative for review.
      - b. Approved 1/8" mini right-angle connectors:
        - 1) Neutrik NTP3RC-B
        - 2) Switchcraft 35HDRABAU
        - 3) Submit proposed alternative for review.
      - c. Approved 1/8" mini chassis connectors (D sized panel connector):
        - 1) Switchcraft EH35MMSSCB
        - 2) Submit proposed alternative for review.
      - d. Approved 1/8" mini chassis connectors:
        - 1) BTX CA-C493
        - 2) RCI Custom RCICH-30-493A
        - 3) Submit proposed alternative for review.
  - I. Ruggedized 8P8C (RJ45) connectors:
    - 1. RJ45 cable connectors shall be with black ruggedized locking shell, with chuck type strain relief.
    - 2. RJ45 chassis connectors shall be ruggedized, latch locking RJ45 type connectors, complying with CAT6A standards.
      - a. Approved Cat6A RJ45 cable connectors:
        - 1) Neutrik NE8MX6 shell with Neutrik CAT6A compliant RJ45 connector.
        - 2) Submit proposed alternative for review.
      - b. Approved RJ45 punch down chassis connectors:
        - 1) Neutrik NE8FDX-Y6
        - 2) Submit proposed alternative for review.

## 2.07 PLATES AND PANELS

- A. Wall plate color in performance areas shall be black, unless otherwise noted. In other areas wall plate color shall be coordinated with the Architect.
- B. Custom plates and panels:
  - 1. Approved manufacturers:
    - a. Panelcrafters
    - b. RCI Custom
    - c. Whirlwind
    - d. Rapco/Horizon
    - e. BTX
    - f. Middle Atlantic Products
    - g. Submit proposed alternative for approval.

## PART 3 EXECUTION

### 3.01 COORDINATION

- A. The AV Contractor shall coordinate this work with the other electrical work and the work of other trades.
- B. Locations shown on AV Drawings are approximate. Refer to Architectural drawings for dimensions.

### 3.02 FABRICATION

- A. Design/Engraving:
  - 1. All equipment controls, receptacles and all indicators shall have, unless otherwise noted, lamacoid, permanently engraved, or silk screened fully descriptive identification labels. The resolution of silk-screened labels shall not be less than 90,000 dots/sq. in.
  - 2. The word "engraved" shall mean that the identification shall be engraved into the indicated panel, plate or control surface.
  - 3. All engraving shall be with 5/32" high characters, unless otherwise noted, and shall be filled with engraver's enamel of a contrasting color.
- B. Custom Plates:
  - 1. Receptacles shall be screwed, bolted or flush-riveted to the plate.
  - 2. Plates shall be marked to indicate the function and circuit of the receptacle, for example: MICROPHONE.
- C. Terminals and Terminations:
  - 1. Microphone cables shall not be spliced or otherwise interrupted from termination to termination. All cables shall have visible adhesive identifying markers on each end.
  - 2. Wiring in terminal cabinets shall be tied and clamped neatly to backboards or cableforms.
  - 3. Terminals shall, unless otherwise specified, be one of the following types:
    - a. Wire-wrap type terminal block.
    - b. Barrier strips with screw terminals.
  - 4. Each terminal strip shall have a legibly marked identification strip.

D. Structural Assemblies:

1. Provide holes required for securing other components or assemblies to structural steel framing and for passage of other components through steel framing members as shown on final shop drawings. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning.
2. In fabricating mounting brackets and other steel components requiring bends, the radii of the bends shall not be less than three times the thickness of the steel being bent.
3. All bolts and nuts used in the fabrication of mounting hardware shall be Grade 5 or better.

### 3.03 INSTALLATION

A. General:

1. Keep the job adequately staffed at all times. Designate a field supervisor to be present on the job site and in responsible charge during all phases of installation and check out. Maintain same supervisor throughout the execution of the work unless circumstances beyond the control of the AV Contractor intervene.
2. Install the system in cooperation with other trades in order to achieve coordinated progress and satisfactory final results. Watch for conflicts with work of other trades on the job.
3. Execute without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment or preserve symmetry and pleasing appearance.
4. The AV Contractor shall do all cutting and patching necessary for proper installation of the system and shall repair any damage done by himself or his workmen. Any required penetration of slabs or CMU walls shall be made by a cutting method rather than by a concussive method.
5. On completion, remove all rubbish and unused materials from the premises and clean the premises and all equipment where dirtied by removing all dirt, dust, stains and fingerprints.

B. Equipment Racks:

1. Supply completely assembled and fully shop-tested racks with all internal wiring completed as required to provide a complete system, to the extent that such items are not provided by others.
2. Install rack mounted equipment with black 10-32 star post drive security screws head screws with nylon washers, Middle Atlantic HTX or equivalent.
3. Wiring internal to equipment racks shall be installed neatly and bundled according to function. Separate power cables as far as possible from microphone level and line level signal cables. Provide lacer bars, horizontal cable managers, and vertical cable managers where required. Attach cable bundles every 6" to cable management.
4. Provide security covers for non-user-operated equipment having front panel controls. Where required by equipment manufacturer security covers shall be vented. Install covers at the conclusion of system test, tuning, and equalization.
5. All blank rack panels and connector panels shall be flanged to increase stiffness. Flat panels will not be accepted.
6. All equipment not available with an integral rack mounting kit shall be provided with a rack shelf including custom faceplate that fully covers any open space around the device. Fasten equipment to rack shelf where appropriate.
7. Provide rack slides for all equipment requiring access to side or top panels for routine adjustment or cleaning.

8. All open areas on front faces shall be covered with blank panels. Where obstructions prevent the installation of full rack space blanks, install  $\frac{1}{2}$  or  $\frac{1}{3}$  space blanks.
  9. Heavy equipment, such as power amplifiers, shall be supported from rear rack rails in addition to front attachments. All equipment in portable equipment racks shall be supported from rear rails in addition to front attachments.
  10. Locate all rack mounted equipment requiring adjustments, cleaning, or similar attention so that it will be accessible. Ensure that equipment with sliding shelves, portable device docks, or user interaction functions operate smoothly without obstruction.
- C. Equipment, Boxes, Plates:
1. Secure all equipment, except equipment designed to be portable, firmly in place, including loudspeakers, racks, amplifiers, cables, and displays.
  2. Install work neatly, with boxes, equipment, etc. plumb and square.
  3. Locate all apparatus requiring adjustments, cleaning, or similar attention so that it will be accessible.
  4. All supporting structures and enclosures supplied by the AV Contractor, not having a standard factory paint finish, shall be painted. Paint specifications and color shall be supplied by the Architect.
  5. The color and finish of blank panels and custom assembly panels shall match adjacent equipment panels to the extent possible. Paint all conduit and boxes to match adjacent surfaces. The finish of wall mounted receptacle panels, including receptacles, shall be coordinated with the Architect.
  6. The equipment specified herein must be capable of operation in environments of normal humidity, dust, and temperature. AV Contractor should avoid installing equipment where extreme environmental conditions can occur and shall be responsible for protection of equipment and related wiring from such conditions.
  7. The AV Contractor shall take precautions to prevent electromagnetic and electrostatic hum.
  8. Install the equipment to provide safe operation. Provide ventilation as required to maintain equipment within the manufacturer's specified temperature limits.
  9. Any obstructions or conflicts in the rated coverage pattern of loudspeakers not shown on design drawings shall be reported to the Consultant. If unreported obstructions are found during testing, the Contractor shall move loudspeakers without claim for extra payment.
- D. Installed Cabling and Conduit:
1. Provide all cables necessary for interconnection of permanently mounted equipment. Use terminations required to achieve full function of equipment as specified herein.
  2. All cables shall be continuous and only spliced where approved on shop drawings.
  3. Exercise care in wiring to avoid damage to the cables and to the equipment. Make all joints and connections with rosin-core solder or with mechanical connectors approved for Class I wiring.
  4. Run lines in separate metallic conduits for microphone level circuits (up to -20 dBm), line level circuits (up to +30 dBm), loudspeaker circuits (above +30 dBm) and power circuits. Non-metallic or PVC conduits for AV system wiring are not acceptable unless otherwise noted. Use only cables which are insulated from the conduit and from each other for the entire conduit length.
  5. Ground audio cable shields at both ends. Provide green heat shrink tubing for all exposed cable shields or shield drain conductors at termination points.

6. Provide the separation shown in the following chart between conduits carrying the following signal types. Where conduits must cross and separation cannot be maintained, cross at a 90-degree angle.
- E. Wire Terminations:
1. Make connections using rosin-core solder or approved mechanical connectors.
  2. Terminate three pin XLR connectors according to AES12-1992 (r2004) standard: Pin 1 = Shield, Pin 2 = Audio High (+), Pin 3 = Audio Low (-). Do not connect shields to connector shells.
  3. Field terminated Speakon connectors shall be terminated with screw terminals. Do not tin wires or solder connectors. Strip 20mm from cable jacket and 8 mm from conductor insulators as directed by manufacturer. Use only an appropriate Pozidriv bit when tightening screw terminals.
  4. Speakon chassis connectors shall be terminated with 4.8mm x 0.5mm Faston crimp connectors.
  5. Provide only factory terminated HDMI, DVI, and DisplayPort digital video cables. Field terminated cables shall not be acceptable.
- F. Portable Cabling: Provide portable cabling required to connect all portable equipment specified by this section.
- G. Labeling:
1. Clearly, logically, and permanently mark switches, connectors, jacks, relays, receptacles, cables, and cable terminations.
  2. Etch, engrave, silk screen or apply in a similar permanent manner all legends and markings on all custom panels and receptacle plates. Embossed tape, press type, etc., are not acceptable.

### 3.04 TESTING

- A. Instrumentation: The AV Contractor shall provide the following test equipment for use during initial tests and adjustments and during acceptance testing and final adjustment of the system:
1. Sound Level Meter: Shall meet ANSI S1.4 specifications for Type I sound level meters. SMAART with a Type I microphone and calibrator is acceptable.
  2. Sine Wave Generator: Continuously variable from 20 Hz to 20,000 Hz within +1 dB with less than 0.5% THD.
  3. Pink Noise Generator: Generator shall produce at least 1 volt RMS of pink noise.
  4. AC Voltmeter: With frequency response of +1 dB from 20 to 20,000 Hz, 0.0001 volts to minimum input impedance of 0.1 megohm.
  5. Polarity checker: Studio Six Digital AudioTools speaker polarity module or equivalent.
  6. Data Communications Cable Verifier: Fluke MicroScanner PoE Industrial or equivalent.
  7. All other equipment required to conduct tests, equipment setup and checkouts outlined in this specification.

- B. System compliance testing and documentation. The Contractor shall perform the following tests and provide a compliance document confirming the results of all tests prior to the final Consultant site visit.
1. Audio System Tests:
    - a. Emergency Systems Muting: Coordinate with others to test emergency system mute. Document verification of system mute.
    - b. Cabling:
      - 1) Check each microphone and line level cable for continuity of all conductors. Verify connectors are terminated in accordance with AES12-1992 (r2004). Document compliance on each line.
      - 2) Check each loudspeaker line for continuity. Positive polarity shall be marked with red or white. Negative polarity shall be marked black.
    - c. Loudspeaker Physical Alignment: Verify the height, vertical angle, and horizontal angle of all loudspeakers with a laser inclinometer. Document the measured aiming angles.
    - d. Loudspeaker Line Impedance: Measure and document the impedance of each loudspeaker and associated loudspeaker line. Using an audio impedance meter (not DC resistance). Measure full range loudspeaker impedance at 200 Hz and 2000 Hz. Measure subwoofer impedance at 50 Hz and 100 Hz. Measure high frequency driver impedance at 4000 Hz and 8000 Hz. A full range impedance sweep using a software impedance meter is also acceptable.
    - e. Loudspeaker Polarity: Perform polarity checks on all independent loudspeakers. Loudspeakers utilizing active crossovers shall have polarity checked on all individually amplified components. Results from all polarity checks shall be included in compliance documentation.
    - f. Freedom from Buzzes, Rattles and Objectionable Distortion:
      - 1) Apply a slow continuous sine wave sweep at a level 3 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles, and objectionable distortion. Correct any causes of these defects, unless the cause is clearly outside the sound amplification system equipment and installation, in which case, the cause shall be brought to the attention of the Consultant.
      - 2) Listen for audible buzzes or noise in the audio system. Coordinate the operation of other building equipment, including but not limited to dimmers, motors, stage lifts, and HVAC equipment to ensure that normal operation of such devices does not cause audible noise in the sound system.
    - g. Assistive Listening Systems: Verify that the system covers all portions of the audience area with no audible signal dropouts.
    - h. Gain Control Settings: Establish tentative normal settings for all gain controls. All gain controls on rack-mounted equipment shall be adjusted for optimum signal-to-noise ratio and signal balance. Settings may require further adjustment by the AV Contractor as a result of testing by the Consultant. After final gain and attenuator

settings have been established, mark all control settings with an adhesive indicator dot or arrow.

- i. Freedom from Switching Transient Noise: Operate all control switches and relays, while listening for clicks and pops in the system outputs. Eliminate any found.
- j. Listening Test: Listen to normal program material to be sure that there are no remaining defects.

2. Video System Tests:

- a. Viewing Test: Apply SMPTE split field color bars to an input of the video system and adjust all displays and projectors. Adjust hue and saturation controls for optimum picture quality and colorimetric uniformity. Route program material from each video source to each display. Watch for ghosting and any effects of excessive VSWR. Correct and defects found.
- b. Video Projector Alignment: Align all video projectors for optimal focus and horizontal and vertical linearity with a crosshatch signal applied to the projector.
- c. Digital Video Distribution: The digital video distribution systems shall meet all the requirements of the manufacturer as described in the manufacturer's specifications. Including available network bandwidth, EDID management, and video latency, embedded audio passes and routes properly, and HDCP compliance.
- d. Resolution and Signal Types: Test all available inputs for standard resolutions and all available signal types.
- e. Video Quality:
  - 1) Confirm the absence of processing errors throughout the entire video system chain using calibrated test generators or applicable software. Confirmation must specifically include but not be limited to the following parameters:
    - (a) Frequency Response
      - 1 Compression Fidelity
      - 2 Subjective Image Fidelity
      - 3 Display Gamma
      - 4 Color Conversion Accuracy
      - 5 Color Matrix Mismatch
      - 6 White and Black Clipping
      - 7 Color Phase and Gain
      - 8 Lip-Sync
      - 9 Chroma Motion
      - 10 Error Noise
  - 2) The digital video distribution systems shall meet all the requirements of the manufacturer as described in the manufacturer's specifications. Including available network bandwidth, EDID management, video latency, and HDCP Compliances where applicable.
  - 3) Reporting: Upon completion of the above tests and any necessary adjustments, submit a written report presenting test results for review by the Consultant prior to acceptance testing, final tuning, and demonstration. With this report, submit written certification that the installation conforms to



the requirements stated herein, is complete in all respects, and is ready for inspection, testing, and final tuning.

3. Data Communications Cable Tests:
  - a. Test 100% of all dedicated AV System network cables installed. Perform the following cable tests as specified herein:
    - 1) Network cable testing:
      - (a) Perform the permanent link test on all 4-pair UTP horizontal cables.
      - (b) Field test the following transmission performance parameters of all four-pair UTP copper cables must have the following data recorded and submitted:
        - 1 The cable tester used during testing.
        - 2 Overall pass/fail for the circuit
        - 3 Pass/Fail for each parameter
        - 4 Cable ID/Pair #
        - 5 Wire map test including continuity to the remote end, shorts between any two or more conductors, crossed pairs, reversed pairs, split pairs, and other miscellaneous wiring errors.
        - 6 Cable Length including individual length of each pair
        - 7 Attenuation to Crosstalk (ACR) ratio
        - 8 Link speed verification
        - 9 Power over Ethernet verification
        - 10 The Dielectric Constant and Velocity of Propagation must also be provided from the manufacturer's data sheet of the cable tested.
  - b. Fiber Optic Tests:
    - 1) Submit test results according to the Submittals section of this specification.
    - 2) Submit data sheets and the last calibration certificate on the optical fiber test equipment that is being used.
    - 3) Factory Tests:
      - (a) All fiber optic cable procured shall be factory tested. Submit factory test results as part of the test reports.
    - 4) Power Meter Testing:
      - (a) Each fiber strand shall be tested for end-to-end link attenuation with optical power meters after installation.
      - (b) Testing shall be in compliance with ANSI/TIA/EIA-568-B and ANSI/TIA/EIA-526-14A, Method B for multimode fibers.
      - (c) Testing shall be in compliance with ANSI/TIA/EIA-568-B and ANSI/TIA/EIA-526-7 for single-mode fibers.
      - (d) End-to-end link attenuation testing shall include the cable under test and the connectors at both ends and shall be performed between the patch panels.
      - (e) Test multimode fiber optic cables in one direction at both the 850nm and 1300nm operating wavelengths.
      - (f) Test single-mode fiber optic cables in one direction at both the 1310nm and 1550nm operating wavelengths.
      - (g) Record the length of each fiber optic link using cable markings or any other suitable method.

- (h) Review measured test results against calculated expected values and correct any installed fiber prior to submitting test results.
  - (i) Power Meter test reports shall include the following: a separate printout for each fiber strand at each operating wavelength that includes the fiber cable ID, the measured link loss in dB, the calculated link loss in dB and the length of the fiber under test.
- 4. Reporting: Upon completion of the above tests and any necessary adjustments, submit a written report presenting test results for review by the Consultant prior to acceptance testing, final tuning, and demonstration. With this report, submit written certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, testing, and final tuning.

### 3.05 TEST, TUNING, AND EQUALIZATION PROCEDURE

#### A. Test Phase:

1. Upon approval of the preliminary test report by the Consultant, schedule the initial post-construction Consultant site visit. During the visit, demonstrate the operation of each major component of the system and the completed installation. After demonstration, assist as required in the following acceptance tests:
  - a. Listening Tests: These tests may include speech intelligibility survey and subjective aural evaluations by observers at various positions under various operating conditions, using live speech and/or recorded music material.
  - b. Equipment Tests: Any measurements of frequency response, distortion, noise or other characteristics and any operational tests deemed necessary may be performed on any item or group of items to determine conformity with these requirements.
2. If the need for adjustment or modification becomes evident during demonstration and testing, continue working until the installation operates fully in accordance with the requirement of this specification. The Consultant will prepare a punch list detailing any deficiencies found during the test phase.
3. The tuning and equalization procedure shall only take place once all work has been completed and tested by the Consultant.

#### B. Tuning and Equalization Phase:

1. After punch list items identified in the test phase have been completed, assist the Consultant in performing the tuning and equalization phase.
2. During the tuning and equalization phase, AV system components shall be adjusted by the Contractor under the direction of the Consultant to optimize the performance of the AV systems. The Contractor will document all changes and include them in the as built drawings. The AV systems installation will not be considered complete until Consultant has completed the system commissioning.
3. The tuning and equalization phase requires that the location of the Work be absolutely quiet. No other work may be performed during the procedure, except that which generates no noise. If the room is not quiet upon the arrival of the Consultant and other work cannot be stopped for the duration of the visit, the Consultant will reschedule the tuning and equalization procedure at additional cost.
4. The Contractor shall provide a technician familiar with the Work during the test, tuning, and equalization procedure. It is estimated that this technician should be available for approximately one eight-hour day. This time shall be solely dedicated to the tuning and

equalization procedure and does not include time spent making the system functional or completing items on the test phase punch list.

5. The Test, Tuning, and Equalization procedure shall take place before the system is turned over to the Owner or training occurs.

### 3.06 DOCUMENTATION

#### A. Project Record:

1. The AV Contractor shall supply clean As-Built prints of the system drawings which show all changes which were made during fabrication and installation.
2. The AV Contractor shall supply clean prints of all previously submitted and approved shop drawings, revised to show all changes which were made during fabrication and installation.
3. The AV Contractor shall print a full-sized copy of the system one line diagram on rigid foamcore board and post it in a convenient location near the equipment rack.

#### B. Maintenance Manual:

1. The AV Contractor shall provide technical information for all electronic apparatus, including but not limited to schematic diagrams and parts lists, manufacturer's installation instructions, operating instructions, and technical specifications.
2. The AV Contractor submittal shall include all shop drawings prepared and used by the AV Contractor, as well as those which were not required to be submitted for approval. This shall include, but not be limited to, wiring diagrams, schedules for identification of building wiring and installation details useful to a maintenance technician.

#### C. Instruction Manuals:

1. Provide two (2) copies of an Instruction Manual to the Owner containing the following:
  - a. Title Page
  - b. Table of Contents
  - c. Description of each system including key features and operational concepts
  - d. Setup diagrams and instructions to use in typical situations as directed by the Owner.
  - e. Single-line block diagrams showing all major system components.
  - f. Manufacturer's operation manuals and information sheets for equipment intended for operation by system users.
  - g. Key schedule cross-referencing all keys to their respective functions and extra copies of all keys required to open or operate equipment specified in this section.

### 3.07 TRAINING AND INSTRUCTION

- A. A minimum of sixteen (16) hours of training shall be provided by the AV Contractor to Owner-designated representatives for all installed systems at a time mutually agreed upon between Owner and AV Contractor. The total training time may require that the training be broken into multiple sessions. No single training session shall exceed four (4) hours.
- B. All training shall be recorded by the AV Contractor. AV Contractor shall provide two (2) copies of the training video on a format suitable to the Owner. AV Contractor will supply the equipment necessary to record the training sessions.
- C. During the training, the participants shall be given opportunities for "hands-on" experience with operating the controls. There shall be visual and audible demonstrations using the systems themselves as aids. Personnel for instruction and training for the AV systems shall be designated by the Owner.

END OF SECTION

## SECTION 275123.50 - EDUCATIONAL PUBLIC ADDRESS, INTERCOM, AND PROGRAM SYSTEMS

### 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: Microprocessor-switched telephone/intercommunications and program systems with the following components:
  - 1. Amplifier.
  - 2. Zone Controller(s)
  - 3. IP-based intercom/messaging speakers.
  - 4. Loudspeakers.
  - 5. Conductors and cables.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For educational intercommunications and program systems. Include plans, elevations, sections, details, and attachments to other work.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For educational intercommunications and program systems to include in operation and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. A record of Owner's equipment-programming option decisions.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain educational intercommunications and program systems from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for location and application.
- D. Comply with NFPA 70.

#### 1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted speaker microphones and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by:
  - 1. AtlasIED.
  - 2. Valcom.

3. Bogen.

2.2 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS

- A. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.
- C. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz. Comply with UL 813.
- D. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

2.3 ZONE CONTROLLER

- A. Description: Microprocessor-based paging zone controller converting an IP-based signal to line level audio for use in constant-voltage paging system.
  - 1. Communication Protocol: IP via SIP or .
  - 2. Input: Ethernet.
  - 3. Output: Line level, unbalanced.

2.4 ALL-CALL AMPLIFIER

- A. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

2.5 IP-BASED INTERCOM/MESSAGING SPEAKERS

- A. Description: Wall-mounted loudspeaker with integral talkback feature and integral digital display for clock or messaging.
  - 1. Communication Protocol: IP via SIP.
  - 2. Power: Power over Ethernet (PoE).

2.6 CONE-TYPE LOUDSPEAKERS

- A. Wall-mounted or ceiling-mounted.
- B. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
- C. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
- D. Minimum Dispersion Angle: 100 degrees.
- E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
- F. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.
- G. Baffle: For flush speakers, minimum thickness of 0.032-inch (0.8-mm) aluminum with textured white finish.
- H. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.

2.7 HORN-TYPE LOUDSPEAKERS

- A. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.
- B. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.
- C. Minimum Power Rating of Driver: 15 W, continuous.
- D. Minimum Dispersion Angle: 110 degrees.

- E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

## 2.8 CONDUCTORS AND CABLES

- A. UTP Cable: Reference Section 271500, Communications Horizontal Cabling.
- B. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
- C. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
- D. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
  - 1. Minimum Shielding Coverage on Conductors: 60 percent.
- E. Plenum Cable: Listed and labeled for plenum installation.

## PART 3 - EXECUTION

### 3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

### 3.2 INSTALLATION OF RACEWAYS

- A. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

### 3.3 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements:
  - 1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
  - 2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
  - 3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
  - 5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring.

Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

- A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- C. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.6 SYSTEM PROGRAMMING

- A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  1. Schedule tests with at least seven days' advance notice of test performance.
  2. After installing educational intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
  3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
  4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
  5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:



- a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging speakers.
  - b. Minimum acceptable ratio is 45 dB.
- 6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each amplifier. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
- 7. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
- C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.
- D. Educational intercommunications and program systems will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.8 STARTUP SERVICE

- A. Perform startup service and initial system programming.
  - 1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
  - 2. Complete installation and startup checks according to manufacturer's written instructions.

### 3.9 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two] ???Insert number??? visits to Project during other-than-normal occupancy hours for this purpose.

### 3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the educational intercommunications and program systems.

END OF SECTION

## SECTION 280010 - ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Conditions, Special Conditions, and Contract Documents are part of these specifications. Consult them further for instructions and be governed by the requirements contained there under.

#### 1.2 DESCRIPTION

##### A. Work Included

- 1. Work shall consist of furnishing all labor, equipment, supplies and materials, unless otherwise specified, necessary for the installation of complete electronic safety and security (Electronic Access Control, Intrusion Detection, and Security Camera) systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract. The work shall also include the completion of those details of work not mentioned or shown which are necessary for the successful operation of all electronic safety and security systems.

##### B. Work Not Included

- 1. Certain labor, materials, and equipment may be furnished under other sections of these specifications, by Service Providers or by the Owner; when this is the case, the extent, source, and description of these items will be as indicated on the drawings or as described in the specification.

#### 1.3 PROVISIONS

- A. Work performed under this division of the specifications shall conform to the requirements of Division 1, the technology systems drawings, and all items hereinafter specified.
  - 1. Prior to any work being performed under this division, examine the following drawings and specifications:
    - a. Architectural
    - b. Structural
    - c. Civil
    - d. Mechanical
    - e. Electrical
  - 2. If any discrepancies occur between other drawings and specifications and the technology systems drawings and specifications, report discrepancies to the Architect in writing and obtain written instructions for the work.
  - 3. Technology Systems drawings are diagrammatic but shall be followed as closely as actual construction of the building will permit. All changes from drawings necessary to make the work conform to the building as constructed shall be made without additional cost to the Owner.
  - 4. Coordinate the work with the General Contractor and/or the Electrical Contractor and be responsible to them for satisfactory progress of the same. Coordinate work with all other trades on the project without additional cost to the Owner.
  - 5. All work and materials covered by drawings and specifications shall be subject to review at any time by representatives of the Architect and Owner. If the Architect or Owner's agent finds any materials or installation that does not conform to these drawings and specifications, Contractor shall remove the material from the premises and correct the installation to the satisfaction of the agent.
  - 6. In acceptance or rejection of installed systems, no allowance will be made for lack of skill on the part of the installers.

#### 1.4 CODES AND STANDARDS

- A. The latest editions of the following standards (including supplements and official interpretations) are minimum requirements:
  - 1. NFPA 70 - National Electrical Code (NEC)
  - 2. NFPA 72 – National Fire Alarm Code
  - 3. NFPA 101 – Life Safety Code
  - 4. All applicable State and Local Codes
  - 5. American National Standards Institute (ANSI)
  - 6. National Electrical Safety Code (NESC)
  - 7. Americans with Disabilities Acts (ADA) and American National Standards Institute (ANSI) 117
  - 8. National Electrical Manufacturer’s Association (NEMA)
  - 9. Underwriter’s Laboratories (UL)
  - 10. Insulated Cable Engineers Association (ICEA)
  - 11. International Building Code
  - 12. Institute of Electrical and Electronic Engineers (IEEE)
  - 13. Building Industry Consulting Services International (BICSI) publications
  - 14. Telecommunications Industry Association (ANSI/TIA) standards and publications
  - 15. Security Industry Association (SIA) standards and publications.
- B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent or conflict with the drawings and specifications.

#### 1.5 SPECIAL REQUIREMENTS

- A. Definitions: “Provide” shall mean “furnish and install”. “Furnish” means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application. “Install” means to join, unit, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation. The words “accept” or “acceptable” denote only that the equipment items are in general conformance with the design concept of the project.
- B. Drawings:
  - 1. The drawings indicate the general arrangement and location of outlets, devices, main/intermediate distribution frames, major pathways, and other work. Information shown on the drawings is schematic. Drawings and specifications are complementary to each other. What is called for by one shall be as binding as if called for by both. Data presented on these drawings is accurate as planning can be determined, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all Architectural, Structural, Mechanical and Electrical Drawings and Specifications; adjust all work to conform to all conditions shown therein. The Architectural drawings shall take precedence over all other drawings.
  - 2. Discrepancies between different plans, between plans and specifications, between specifications or regulations and codes governing this installation shall be brought to the attention of the Architect in writing before the date of bid opening. In the event such discrepancies exist, and the Architect is not so notified, the adjudication of responsibility shall be solely at the discretion of the Architect.

#### 1.6 EXAMINATION OF BIDDING DOCUMENTS

- A. Each bidder shall examine the bidding documents carefully, and not later than seven days prior to the date of receipt of bids, shall make written request to the Engineer for interpretation or correction of any discrepancies, ambiguity, inconsistency, or error therein which he may discover. Any interpretation or

correction will be issued as an addendum by the Architect. Only a written interpretation or correction by addendum shall be binding. No bidder shall rely upon interpretations or corrections given by any other method. If discrepancies, ambiguity, inconsistency, or error are not covered by addendum or written directive, Contractor shall include in his bid, labor materials and methods of construction resulting in higher cost. After award of contract, no allowance or extra compensation will be made on behalf of the Contractor due to his failure to make the written requests as described above.

- B. Failure to request clarification during the bid period of any inadequacy, omission, or conflict will not relieve the Contractor of their responsibilities. The signing of the contract will be considered as implicitly denoting that the Contractor has a thorough comprehension of the full intent and scope of the working drawings and specifications.

#### 1.7 PERMITS, FEES & NOTICES

- A. Obtain and pay for all necessary permits, inspections and certificates that may be necessary for the full completion of the work. Furnish the Owner with a certificate of final inspection and approval from the AHJ over the electrical installation.
- B. Notify proper authorities when work is ready for inspections required by applicable codes, rules and regulations, allowing sufficient time for inspections to be made without hindering progress of the work. Furnish to the Owner copies of inspection certificates of acceptance.

#### 1.8 TESTS

- A. Upon completion of all work and adjustment of all equipment, provide complete operational tests of all systems provided under this division.

#### 1.9 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Installer must have personnel certified by applicable manufacturers on staff.
  - 2. Installer must have minimum 5 years previous experience with installation of access control, intrusion detection, and CCTV systems utilized on this project. Contractor shall provide references upon request.

#### 1.10 WARRANTY

- A. Guarantee that all work governed by this division shall be free of defects in workmanship, materials and parts for a minimum period of one (1) year after written acceptance. Promptly repair, revise, and replace defects as directed with no additional cost to the Owner.
- B. Where extended warranties are to be provided, Contractor shall be fully certified by applicable manufacturer for install as to provide such extended warranty.

#### 1.11 SUBMITTALS

- A. Submit under provision of Division 1.
- B. Action Submittals:
  - 1. Product data and shop drawings submittals shall be submitted in electronic (PDF) format, indexed in a neat and orderly manner.
  - 2. Product Data: For each type of product indicated.
    - a. Listing of Equipment: The Contractor shall submit a complete typewritten list of those items of components and equipment which will be furnished under this contract. Include the name or description of the item, name of manufacturer, model, type, and catalog number.
    - b. Product Data Cutsheets: For communications systems. Include formal product data cutsheets for review.

- 1) Submittals must clearly indicate specific products and materials intended to be used on this project, including part numbers and applicable options. Properly identified products to be used includes outline or highlighting of intended part numbers.
  - 2) Submittals associated with equipment or components identified with an equipment tag (i.e. "LS-1") in the Drawings shall be identified with the associated equipment tag on the cutsheet.
  - 3) Product data submittals shall be submitted as separate files/packages per Specification Section.
  - 4) Product data submittals shall utilize in-document links or bookmarks, linking line items in the Listing of Equipment to the corresponding product data sheets.
  - 5) Submittals returned with "revise & resubmit" or "reject" for specific components shall be resubmitted with revised product data for items in noncompliance only.
  - 6) Submittals shall not be used to process Contractor-initiated substitutions. Reference 270010, 2.3 – "Substitutions (Contractor and/or Owner Initiated)".
3. Shop Drawings: For electronic security systems. Include plans, elevations, sections, diagrams, details, and other similar illustrations of the work. Submittal shall be made prior to any fabrication/installation and within the time schedule approved by the architect and General Contractor as shown on the electronics systems Bar Chart milestones submitted approved during the Product Data submittals.
- a. All shop drawing Submittals shall be engineered and drawn on a vector or raster-based CAD system (AutoCAD or REVIT preferred).
  - b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - c. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - d. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
  - e. Complete floor plans, at scale of contract documents, showing the locations throughout the project of all outlets, pathways, wire ways, pull boxes, junction boxes, equipment racks, telecom rooms, AV rooms, and other devices associated with the systems specified here within.
  - f. Complete system riser diagrams, showing all elevations, room numbers, pathway sizes, types and fills, box sizes and types, devices, equipment and rack designations.
  - g. Complete scaled (1/4" = 1") equipment rack elevation drawings, including equipment designations, manufacturers name, and model number, power distribution and requirements within the racks and connection to power panels by the electrical contractor outside the racks.
  - h. Complete heat generation details by device totaled per room shall be compiled in spreadsheet form.
- C. Informational Submittals:
1. Qualification Data: For installers and installation supervisor.
  2. Warranty Data: For products complying with extended warranties.
- D. Closeout Submittals:
1. Product data and shop drawings submittals shall be submitted in electronic (PDF) format, indexed in a neat and orderly manner.
  2. Evidence of Warranty:
    - a. Document of contractor's warranty, indicating start and end dates of warranty effect, and contact information for Contractor.

- b. Document of manufacturer's warranty, indicating contact information for manufacturer support.
  - c. Document of manufacturer's extended warranty, indicating contact information for manufacturer support.
- 3. Operations & Maintenance (O&M) data:
  - a. Include final, reviewed product data cutsheets of all equipment and components presented in the submittal process.
  - b. Include operational manuals for pertinent equipment.
  - c. Include any specific maintenance routines or methods for equipment or components.
  - d. Requirements associated with Product Data submittal listed above shall apply.
- 4. System Configurations:
  - a. Include three (3) copies of thumb-drive or other physical media containing compiled programming files, source code files, system configuration files, and other digital information associated with pertinent systems.
  - b. Files shall be presented in a format that can be restored to system or manipulated and updated to system.
- 5. As-Built Drawings:
  - a. Include plans, schematics, diagrams, and details representing the final, as-built conditions of the project.
  - b. General cable routing, outlet designations and labeling, and other descriptive information shall be represented on the as-built drawings.
  - c. Drawings shall be provided in PDF format using vector- or raster-based drawing platform (AutoCAD or Revit preferred). Hand-drawn as-builts are not acceptable.
- E. Incomplete initial submittals, or product data submittals not clearly identifying part numbers intended to be used for this project, will not be accepted.
- F. Installation manuals are not acceptable alternates for product data cut sheets.
- G. Contractors performing any work, including ordering or installation of product, without applicable reviewed submittals do so at their own risk.
- H. Submit additional shop drawings, layouts, manufacturer's data, wiring diagrams and material schedules that may be requested by the Architect or Engineer for their review. The review by the Architect will not constitute concurrence with any deviation from the plans and specifications unless such deviations are specifically identified by the method described below, nor shall it relieve the Contractor of responsibility for errors or omissions in the submitted data.
- I. Processed shop drawings shall not be construed as change orders. The shop drawings shall demonstrate that the Contractor understands the design concept, indicate which equipment and materials the Contractor intends to provide, and detail the fabrication and installation methods the Contractor intends to use. If deviations, discrepancies or conflicts between submittals and the design drawings and specifications are discovered, the design drawings and specifications shall govern.
- J. Contractor shall be responsible for dimensions (which shall confirm and correlate at the job site), fabrication processes and techniques of construction and coordination of their work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them and sign a statement on the shop drawings which signifies that they comply with plans and specifications and that equipment is dimensionally suitable for the application. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal. The Owner's copies of the reviewed submittals shall be retained by the Contractor until completion of the project and presented in bound form to the Owner.

#### 1.12 RECORD DRAWINGS

- A. Maintain a current set of electronic safety and security drawings at the site. Neatly mark all changes and deviations from the original drawings. Use a color which contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses and shall be made available for inspection by the Architect and Engineer at all times. These updated progress drawings shall be used to produce the final record drawings that shall be in AutoCAD electronic format media upon project completion.
- B. Upon completion of the contract, both sets (electronic and hard copy drawings) of record drawings shall be delivered to the Architect.
- C. The Contractor shall mark all record drawings on the front lower right hand corner with a stamp impression that reads 'RECORD DRAWINGS' or similar.

#### 1.13 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prior to submitting a bid, visit the site of job and ascertain all conditions affecting the proposed installation and adjust all work accordingly. Make provisions for these costs.
- C. Coordinate the work with that of all other trades. Where conflicts of work occur and departure from the indicated arrangements are necessary, consult with other Contractors involved; come to agreement as to changed locations and elevations, etc., and obtain written acceptance from the Architect of proposed changes before proceeding with work.
- D. All outages of pre-established service shall be scheduled with the Owner and Service Provider five (5) days in advance of proposed outage. Include an overtime allowance in the bid for the performance of all work requiring outages at such time as it is approved by the Owner. Outages shall be at a time and of such duration as accepted by the Owner.

#### 1.14 SEQUENCING AND SCHEDULING

- A. Construct Work in sequence under provisions of Division 1.

#### 1.15 USE OF THE ARCHITECT'S AND/OR ENGINEER'S DRAWINGS

- A. The Contractor shall obtain, at the Contractor's expense, from the Architect or Engineer a set of AutoCAD or compatible format architectural and engineering drawings on electronic media where desired by the Contractor and/or required by the Specifications for use in preparing the shop drawings, coordination drawings, and record drawings. The Contractor shall provide to the Architect and Engineer a written release of liability acceptable to the Architect and Engineer prior to receiving the electronic media.

#### 1.16 USE OF THE ENGINEER'S DESIGN MODEL

- A. The Contractor may obtain the Engineer's Design Model at time of design team's major deliverables. Contractor shall sign Engineer's "Design Model Release Authorization" prior to receiving Design Model from Engineer.
- B. At no time shall the Design Model be used for the basis of RFIs, Change Orders, or other similar purposes. The Drawings and specifications produced shall govern.

### PART 2 - PRODUCTS

#### 2.1 STANDARD FOR MATERIALS

- A. All materials shall conform to current applicable industry standards. Workmanship and neat appearance shall be as important as the system operation. Defective or damaged materials shall be replaced or

repaired, prior to final acceptance, in a manner acceptable to the Architect, Engineer or Owner at no additional cost to the Owner.

- B. All materials shall be acceptable for installation only if labeled or listed by a nationally recognized testing laboratory and if accepted by local authorities.
- C. All materials shall be acceptable for installation only if in compliance with requirements set forth in this specification.

## 2.2 BID ALTERNATE(S)

- A. Refer to Division 1 and all contract documents for additional information.
- B. Alternate(s) for Material and Equipment
  - 1. Equipment and material bid alternate(s) shall be proposed as additive or deductive alternate(s) to specified items by submitting it as a separate line item from the base bid on the Bidder's letterhead.
  - 2. Such bid alternate proposals shall not be substituted or included in the base bid. Bid alternate proposal(s) must be accompanied by full descriptive data on the proposed equipment, together with a statement of the cost to be added or deducted for each item. The bid alternate shall include all materials, equipment, labor, connections, coordination with all other trades, etc. for a complete and operational system.
  - 3. The Contractor shall submit the bid alternates at the time the base bids are due.

## 2.3 SUBSTITUTIONS (CONTRACTOR AND/OR OWNER INITIATED)

- A. Materials or equipment listed by several manufacturers' names are intended to be bidder's choice, and any of the listed manufacturers may be used in the base bid. Materials or equipment not listed are considered substitutions.
- B. Performance Specification: When any item is specified by requirement to meet a performance, industry or regulating body standard or is specified generically (no manufacturer's name listed), no prior review by the Engineer is needed unless specifically called for in these specifications.
- C. Contractor to be responsible for any changes and costs to accommodate any equipment except the first named in the specification.
- D. Substitutions for Material
  - 1. Equipment and materials not listed as equivalents may be proposed as deductive alternates to specified items by submitting it as a separate line item to the base bid on the Bidder's letterhead.
  - 2. Such substitutions shall not be substituted for the base bid and must be accompanied by a full description of the difference between the Contract Document requirements and that of the substitution, the comparative features of each, and the effect of the change on the end result performance. Include the impact of all changes on other contractors and acknowledge the inclusion of additional costs to the other trades. If any such alternates are considered, the Contractor shall submit a list of the proposed alternate substitution items within 14 days of award of contract. Late requests for proposed substitutions will not be accepted by the Engineer due to scheduling or delivery concerns.

## PART 3 - EXECUTION

### 3.1 WORKMANSHIP AND COMPLETION OF INSTALLATION

- A. Contractor's personnel and subcontractors selected to perform the work shall be well versed and skilled in the trades involved.
- B. Coordinate equipment and materials installation with other building components.
- C. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring specific positioning.



- D. Any changes or deviations from the drawings and specifications must be accepted in writing by the Architect/Engineer. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where detail or specific installation requirements are not provided, manufacturer's recommendations shall be followed.
- E. Upon completion of work, all equipment and materials shall be installed complete, thoroughly checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residue shall be removed from surfaces. Exterior surfaces of all material and equipment shall be delivered in a perfect, unblemished condition.
- F. Contractor shall provide a complete installation, including all required labor, material, cartage, insurance, permits, and taxes.

### 3.2 PROGRESS OF WORK

- A. Order the progress of electronic safety and security work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit. Any cost resulting from defective or ill-timed work performed under this Section shall be borne by this Contractor.

### 3.3 TRENCHING AND BACKFILLING

- A. Perform all trenching and backfilling required by work performed under this Section in accordance with the excavating and grading specifications as herein specified. This work shall comply with the requirements of Table 300-5 of the National Electrical Code.
- B. Excavate trenches to the depth required for the utilities involved. The trench bottom shall be graded true and free from stones or soft spots. Trenches through specially treated or surfaced areas, such as paving or blacktop, shall have the width of the surface cutting extended for a width of eight inches (8") on each side of the open trench. Unless otherwise noted, the disturbed surfaces shall be replaced equal to the original construction, to the original grade with the same type of material, and to the same depths and limits as the materials removed. After acceptance by the Architect, backfill, tamp, and compact to insure against the possibility of differential settling, in conformity with Division 2 Specifications. Verify location of existing or new utilities and, if damaged by this Contractor, replace or repair.

### 3.4 CHASES, OPENINGS, CUTTING, AND PATCHING

- A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the Architect. Any necessary cutting, channeling, drilling or anchoring of raceways, outlets, or other equipment shall be performed in a careful manner, and as accepted by the Architect.
- B. All openings made in fire-rated walls, floors, or ceilings shall be patched and made tight in a manner to conform to the fire rating for the surface penetrated.
- C. All penetrations required through existing concrete construction shall be core drilled at minimum size required. Precautions shall be taken when drilling to prevent damage to structural concrete. Contractor shall obtain permission from the Architect before proceeding with drilling.
- D. Provide all cutting, trenching, backfilling, patching and refinishing or resurfacing required for electrical work in a manner meeting the approval of the Engineer and at no additional cost to the Owner.

### 3.5 DELIVERY AND STORAGE OF MATERIALS

- A. Arrange and be held responsible for delivery and safe storage of materials and equipment for installation.
- B. Store materials and equipment for easy inspection and checking.

- C. Carefully mark and store all materials.
- D. Deliver materials to the job site in stages of the work that will expedite the work as a whole.
- E. Carefully check materials furnished to this Contractor for installation, and provide receipt acknowledging acceptance of delivery and condition of the materials received. Thereafter, assume full responsibility for its safekeeping until the final installation has been reviewed and accepted.

### 3.6 PROTECTION OF WORK AND PROPERTY

- A. Where there are existing facilities, be responsible for the protection thereof, whether or not such facility is to be removed or relocated. Moving or removing any facility must be done so as not to cause interruption of the work of Owner's operation.
- B. Close all conduit openings with caps or plugs during installation. Cover all fixtures and equipment and protect against injury. At the final completion, clean all work and deliver in an unblemished condition, or refinish and repaint at the discretion of the Architect.
- C. Any equipment or conduit systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Engineer's satisfaction.

### 3.7 FINAL ACCEPTANCE

- A. Final acceptance by the Owner will not occur until all operating instructions are received, all necessary tests have been demonstrated as "PASS", and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment.
- B. Operating manual, parts lists, and indoctrination of operating and maintenance personnel: Furnish the services of a qualified representative of the supplier for each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.
- C. Instruction shall be made when the particular system is complete and shall be of the number of hours and at the time requested by the Owner. A representative of the Electrical Contractor shall be present for all demonstrations.
- D. Deliver three (3) complete operating manuals and parts lists to the Owner (or his designated representative) at the time of the above required indoctrination. Fully explain the contents of the manuals as part of required indoctrination and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period. The operating manual and parts lists shall give complete information as to whom the Owner shall contact for service and parts, including the address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within twenty four (24) hours after requested.
- E. Clean up: Remove all materials, scrap, etc., relative to the electronic safety and security installation and leave the premises and all equipment, outlets, patchpanels, etc. in a clean, orderly condition. Any costs to the Owner for clean up of the site will be charged against the Contractor.

### 3.8 OWNER PROVIDED EQUIPMENT

- A. Provide required connections to Owner-furnished equipment.
- B. Inspect owner furnished equipment for damage, defects, missing components, etc. Report deficiencies to the Owner immediately. Do not install or connect deficient equipment.
- C. Provide supports, fastenings, and auxiliary hardware necessary for a complete installation in accordance with the finished building conditions.

END OF SECTION

## SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

### 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. UTP cabling.
  - 2. RS-232 / RS-485 cabling.
  - 3. Access Control cabling.
  - 4. Control-circuit conductors.
  - 5. Identification products.
- B. Related Sections:
  - 1. Section 271500 "Communications Horizontal Cabling" for UTP cabling requirements.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.
- B. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.

#### 1.6 FIELD CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
- B. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- C. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 2.2 UTP CABLE

- A. Reference Section 271500, Communications Horizontal Cabling.

#### 2.3 UTP CABLE HARDWARE

- A. Reference Section 271500, Communications Horizontal Cabling.

## 2.4 RS-232 / RS-485 CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden, Inc.
  - 2. CommScope, Inc.
  - 3. West Penn Wire.
  - 4. Liberty Cable.
  - 5. General Cable.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 24 AWG, stranded (7x32) tinned copper conductors.
  - 2. Fluorinated ethylene propylene insulation.
  - 3. Shielding: 100% Aluminum foil with drain wire and 90% tinned copper braid.
  - 4. Fluorinated ethylene propylene jacket.
  - 5. Flame Resistance: NFPA 262.

## 2.5 ACCESS CONTROL CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden, Inc.
  - 2. CommScope, Inc.
  - 3. West Penn Wire.
  - 4. Liberty Cable.
  - 5. General Cable.
- B. Card Reader Cable (Plenum Rated): NFPA 70, Type CMP.
  - 1. Six conductor No. 22 AWG, stranded (7x30) copper conductors.
  - 2. FEP insulation.
  - 3. Shielded with 100% aluminum foil and drain wire.
  - 4. Plenum PVC or FEP Jacket.
  - 5. Gray color.
  - 6. Flame Resistance: NFPA 262.
- C. Door Contact Switch Cable (Plenum Rated): NFPA 70, Type CMP or CL2RP.
  - 1. Two conductor No. 22 AWG, stranded (7x30) copper conductors.
  - 2. FEP insulation.
  - 3. Unshielded.
  - 4. Plenum PVC or FEP Jacket.
  - 5. Gray color.
  - 6. Flame Resistance: NFPA 262.
- D. Locking Mechanism Power Cable:
  - 1. See "Class 2 Control Circuits" specification, below.
- E. Composite Cables:
  - 1. At the Contractor's discretion, Composite Cables may be utilized in lieu of individually run cables for access control systems. Cable configuration and specification shall match specifications for individually listed cables.
  - 2. Contractor shall be responsible to increase size of conduit or pathway accordingly.

## 2.6 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
- B. Class 2 Control Circuits: Stranded copper, power-limited cable, complying with UL 83, concealed in building finishes.

- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

## 2.7 IDENTIFICATION PRODUCTS

- A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

## PART 3 - EXECUTION

### 3.1 WIRING METHOD

- A. Install wiring in metal pathways and wireways.
- B. Minimum conduit size shall be 1 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
- C. Comply with requirements in Section 280528 "Pathways for Electronic Safety and Security."
- D. Install cable, concealed in accessible ceilings, walls, and floors when possible.
- E. Wiring within Enclosures:
  - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
  - 2. Install lacing bars and distribution spools.
  - 3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
  - 4. Install conductors parallel with or at right angles to sides and back of enclosure.
  - 5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
  - 6. Mark each terminal according to system's wiring diagrams.
  - 7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

### 3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6A rating of components and that ensure Category 6A performance of completed and linked signal paths, end to end.
  - 1. Comply with TIA/EIA-568-B.2.
  - 2. Install 110-style IDC termination hardware unless otherwise indicated.
  - 3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- E. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.
  - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
  - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  - 4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
  - 5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
    - a. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

### 3.3 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
  - 1. Class 1 remote-control and signal circuits, No. 14 AWG.
  - 2. Class 2 low-energy, remote-control and signal circuits, No. 18 AWG.
  - 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
  - 4. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

## SECTION 280528 - PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

### 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.
- B. Reference Section 270528, Pathways For Communications Systems, for all requirements.

### PART 2 - PRODUCTS

### PART 3 - EXECUTION

END OF SECTION



SECTION 280544 - SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY

PATHWAYS AND CABLING

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.
- B. Reference Section 270544, Sleeves And Sleeve Seals For Communications Pathways And Cabling, for all requirements.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION

## SECTION 281300 - ELECTRONIC ACCESS CONTROL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Electronic access control system operating system and application software.
2. Electronic access control system controllers connected to high-speed electronic-data transmission network.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Device layout.
2. Wiring diagrams.

#### 1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data include the following:

1. Software documentation.
2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

#### 1.4 QUALIFICATIONS

- A. Installer Qualifications: Installer must be trained and certified by access control system manufacturer, and demonstrate a minimum of five (5) successful projects within the last 36 months utilizing platform, components, and methods similar to this project.

#### 1.5 QUALITY ASSURANCE

- 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 NFPA 70, "National Electrical Code."
- C. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Access Control Platform
  - a. Axis Communications.
2. Access Control Hardware Panels
  - a. Axis Communications.
3. Card Readers
  - a. Schlage.

- B. Alternate Manufacturers: Alternate manufacturers are not allowed.

## 2.2 DESCRIPTION

- A. Security Access System: PC-based central station and field-installed controllers, connected by a high-speed electronic-data transmission network.
- B. Network(s) connecting PCs and controllers shall consist of one or more of the following:
  - 1. Local area, IEEE 802.3 Fast Ethernet Gigabit-Ethernet, star topology network based on TCP/IP.

## 2.3 OPERATION

- A. Security access system shall use a single database for access-control and credential-creation functions.
- B. Field equipment shall include controllers, sensors, and controls.
  - 1. Controllers shall serve as an interface between the central station and sensors and controls.
  - 2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
  - 3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
  - 4. Controllers are classified as alarm-annunciation or entry-control type.
- C. Door Hardware Interface:
  - 1. Comply with requirements in Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for door hardware required to be monitored or controlled by the security access system.
  - 2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.
- D. Security Camera / VMS Interface:
  - 1. Events (valid credential, valid exit, etc.) recorded in the Electronic Access Control System shall timestamp video recorded from cameras viewing the applicable door.
  - 2. Alarms (invalid credential, breach, etc.) created by the Electronic Access Control System shall activate event-based recording of cameras viewing the door under alarm.

## 2.4 APPLICATION SOFTWARE

- A. PC-to-Controller Communications:
  - 1. Central-station or workstation communications shall use the following:
    - a. RS-232 interface cards.
- B. Alarm Monitoring: Monitor sensors, controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.

## 2.5 SURGE AND TAMPER PROTECTION

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
  - 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
  - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## 2.6 CONTROLLERS

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
- D. Entry-Control Controller:
  - 1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
    - a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
    - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
      - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
      - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
    - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
  - 2. Inputs:
    - a. Data from entry-control devices; use this input to change modes between access and secure.
    - b. Database downloads and updates from the central station that include enrollment and privilege information.
  - 3. Outputs:
    - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    - b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
    - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
    - d. Door Prop Alarm: If a portal is held open for longer than time listed in a schedule, alarm sounds.
  - 4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
  - 5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.

- a. Store up to 1000 transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
- 6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
  - a. Backup Battery: Premium, valve -regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata 19 -year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
  - b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
  - c. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.
  - d. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
    - 1) Trouble Alarm: Normal power-off load assumed by battery.
    - 2) Trouble Alarm: Low battery.
    - 3) Alarm: Power off.

## 2.7 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

- A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
- B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
- C. Display: Digital visual indicator shall provide visual and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- D. Touch-Plate and Proximity Readers:
  - 1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
  - 2. The card reader shall read proximity cards in a range from contact to at least 6 inches (150 mm) from the reader.

## 2.8 PUSH-BUTTON SWITCHES

- A. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless-steel switch enclosures.
- B. Electrical Ratings:
  - 1. Minimum continuous current rating of 10 A at 120-V ac or 5 A at 240-V ac.
  - 2. Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.

- C. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
- D. Power: Push-button switches shall be powered from their associated controller, using dc control.

## 2.9 DOOR HARDWARE INTERFACE

- A. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware."
- B. Latch Retraction Mechanisms: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Latch Retraction Mechanisms are specified in Section 087100 "Door Hardware."
- C. Accessibility Door Operators: Coordinate with Section 087100, Door Hardware.

## 2.10 CABLES

- A. General Cable Requirements: Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
- D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

### 3.2 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Install LAN cables using techniques, practices, and methods that are consistent with Category 6A rating of components and fiber-optic rating of components, and that ensure Category 6A and fiber-optic performance of completed and linked signal paths, end to end.
- E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- F. Install end-of-line resistors at the field device location and not at the controller or panel location.

### 3.3 CABLE APPLICATION

- A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).
- D. Card Readers and Keypads:
  - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
  - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
  - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
  - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 500 ft. (150 m).
- F. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. (8 m).

### 3.4 GROUNDING

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

### 3.5 INSTALLATION

- A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- (6.4-mm-) high text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.
- B. Install locking components, card readers and push buttons.

### 3.6 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-A.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, cable and asset management software shall reflect as-built conditions.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
  2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
  3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  3. Security personnel.
  4. Hardware maintenance personnel.
  5. Corporate management.

END OF SECTION



## SECTION 282300 - SECURITY CAMERA SYSTEMS

### 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. Security cameras.
  - 2. Security camera supporting equipment.
  - 3. Video management systems.
  - 4. Information transport cabling.
- B. Related Sections:
  - 1. Section 271100, "Communications Equipment Room Fittings" for related equipment racking equipment.
  - 2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for information transport cabling requirements.
  - 3. Section 280528 "Pathways for Electronic Safety and Security" for conduits, junction boxes, devices boxes, and other infrastructure requirements.

#### 1.3 ADMINISTRATIVE AND COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of security cameras with Owner and Owner's authorized agents.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Comply with Section 280010, "Electronic Safety and Security General Provisions."
- B. 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.
- C. Comply with NECA 1.
- D. Comply with NFPA 70.
- E. Electronic data exchange between Security Camera system and an Access Control system shall comply with SIA TVAC.

#### 1.5 ACTION SUBMITTALS

- A. Reference Section 280010, "Electronic Safety and Security General Provisions" for additional submittal requirements.
- B. Product Data: For each type of product.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Reference Section 280010, "Electronic Safety and Security General Provisions" for additional submittal requirements.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
  - 1. Product Data Cutsheets: For each type of product installed.

2. System Operation Manual: Document describing in plain detail maintenance and operation of security camera system, including everyday operations, moves/adds/changes, etc.
  3. System Configuration: Document indicating all installed devices, IP addresses, Device Names, and initial operational settings.
- B. Warranty: Documentation of proof of warranty, including extended warranties, for products and systems installed.
- C. As-Built: CAD/DWG and hardcopy format of project as-builts, indicating locations, routing, quantities, and other pertinent information for final conditions.

#### 1.8 WARRANTY

- A. Comply with Section 280010, "Electronic Safety and Security General Provisions."
- B. Provide 12-month contractor warranty against installation and workmanship.
- C. Manufacturer's Warranty: Manufacturer's standard warranty in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and management and recording system that fails due to material defect or workmanship on the part of the Manufacturer within the specified warranty period.
1. Warranty Period: Three years from date of Substantial Completion.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test equipment on- or off-site upon receipt.
1. Verify cameras startup and are capable of connection.
  2. Verify management and recording system equipment boot and are capable of connection.
- B. Off-Site Construction: Equipment racks and cabinets may be assembled and programmed off-site. Provide appropriate packing and protection for equipment assembled off-site to be delivered to project site. Cameras and camera mounting may be tested off-site, but delivered to project site in original packaging.
- C. Environmental Limitations: Do not deliver or install equipment until all work with potential to cause damage to such equipment in spaces is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

#### 1.10 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Interior Environment (Cameras): Cameras installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 degrees Fahrenheit (dry bulb) and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
  2. Interior Environment (Management & Recording Equipment): Equipment shall be rated for continuous operation in ambient temperatures of 60 to 95 degrees Fahrenheit and a relative humidity of 20 to 80 percent, noncondensing.
  3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 degrees Fahrenheit (dry bulb) and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick. Use NEMA 250, Type 3R enclosures.

## PART 2 - PRODUCTS

### 2.1 SYSTEM REQUIREMENTS

- A. Security Camera System, General Requirements: System shall be comprised of IP (TCP/IP protocol) compatible components connected to a subnet of the Owner's LAN.
  - 1. All IP cameras shall support H.264 or Motion JPEG compression, 30 frames-per-second, and are powered via PoE.
  - 2. Camera imagery shall be recorded via Video Management System (VMS) with integral storage.
  - 3. Monitoring and control shall be achieved via remote PC connected to the VMS via LAN.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
  - 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
  - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

### 2.2 SECURITY CAMERAS

- A. Manufacturers: Subject to compliance with requirements, provide products as specified on the Drawings, or units matching salient specifications by one of the following:
  - 1. Axis Communications.
- B. Alternate Manufacturers: Alternate manufacturers are not allowed.
- C. Color Dome Camera: Assembled and tested as a manufactured unit, containing camera housing, dome, and lens(es).
  - 1. Reference Drawings for individual camera unit specifications.
  - 2. UL Listed equipment.
  - 3. ONVIF Profile 'S' compliant.
  - 4. Mini-dome form factor.
  - 5. IP-based camera type (TCP/IP supported protocol).
  - 6. AGC, manually selectable on or off.
  - 7. Auto-iris, with manual and automatic day/night adjustment.
  - 8. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
  - 9. Motion Detector: Built-in digital via VMS analytics.
  - 10. Integral analytics engine.
  - 11. On-board 1TB data storage.

### 2.3 VIDEO INTERCOM STATIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Axis Communications.
- B. Alternate Manufacturers: Alternate manufacturers are not allowed.
- C. Acceptable Product:
  - 1. Axis Communications I8116-E Network Video Intercom.

### 2.4 CAMERA SUPPORTING EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Axis Communications.
- B. Source Requirements: Camera supporting equipment shall be provided by same manufacturer as camera units where possible.
- C. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
- D. Mounting Brackets for Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
- E. Protective Housings for Cameras: Steel or aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
  1. Exterior:
    - a. Corner-, wall-, or parapet-mount dome camera gooseneck mount.
    - b. Surface mount housing.
    - c. Built-in thermostatically-activated heater and blower units, where required to maintain environmental limits of camera.
  2. Interior:
    - a. Suspended tile ceiling: Lay-in tile mounting bracket.
    - b. Gypsum board or other hard surface ceiling: Suitable backbox with attachment to structure above.
    - c. Solid or structural ceiling: Surface mount housing.
    - d. Installation suspended below ceiling: Structural-mounted pipe with surface-mount housing.
    - e. Gypsum board wall: Suitable backbox with attachment to wall studs.
    - f. Solid or structural wall: Surface-mount housing.
  3. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
  4. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
  5. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.

## 2.5 VIDEO MANAGEMENT SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Axis Communications.
- B. Alternate Manufacturers: Alternate manufacturers are not allowed.
- C. Acceptable Product: Axis Communications Camera Station.
- D. General Requirements:
  1. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
  2. System shall have seamless integration of all video surveillance and control functions.
  3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
  4. System design shall include all necessary compression software for high-performance, dual-stream, H.264/H.265/Motion JPEG video. Unit shall provide connections for local area network, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
  5. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.

6. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the network designated for CCTV.
  7. VMS shall be controlled via LAN-connected workstation PC.
  8. All system interconnect cables, workstation PCs, control surfaces, and network intermediate devices shall be provided for full performance of specified system.
- E. Video Management System (VMS) Software:
1. VMS Software shall integrate with connected cameras and devices.
  2. Allows for software client and web browser-based interface.
  3. Performs de-warping and image blending of fisheye, panoramic, and multi-sensor cameras.
  4. Capable of viewing multiple cameras on multiple connected monitors with user-defined array.
  5. Includes full-featured search capabilities to search by camera, time, date, and other user-defined parameters.
  6. Indicates motion and alarms recognized by system.
  7. Allows for bookmarking of video footage.
  8. Allows for exporting of recorded data to common multimedia file types.
  9. Compatible with network attached storage server.
  10. Incorporates license plate recognition (LPR).
  11. Incorporates subject-tracking analytics.
  12. Incorporates integration with LDAP / ActiveDirectory.

## 2.6 INFORMATION TRANSPORT COMPONENTS

- A. Comply with requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security."

## PART 3 - EXECUTION

### 3.1 EXAMINATION & COORDINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, installations that may obscure desired camera viewing, and other conditions affecting installation.
- B. Perform a "box walk" with Owner's personnel at a minimum to confirm camera locations and mounting heights.
- C. Examine structured cabling installation network connections before device installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Meet with Owner's personnel to determine networks, switch locations (if Owner-provided), subnets, and IP address blocks to be used for security camera purposes. Confirm with Owner's personnel designated NVR equipment location. Document all parameters and decisions.

### 3.2 PATHWAYS AND CABLING

- A. Comply with requirements in Division 28 Section "Raceway and Boxes for Electronic Safety and Security."
- B. Comply with requirements in Division 28 Section "Conductors and Cabling for Electronic Safety and Security."

### 3.3 SECURITY CAMERA INSTALLATION

- A. Install cameras level and plumb.
- B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- C. Provide mounting accessories and appurtenances for finished installation.

- D. Connect security cameras to security network.
- E. Initiate and configure licensing as required.
- F. Aim and focus cameras.

### 3.4 VIDEO MANAGEMENT SYSTEM INSTALLATION

- A. Configure VMS.
  - 1. Meet with Owner's personnel to determine desired user interface layout, recording parameters, camera/camera group aliases, and other user defined settings. Document all decisions and parameters.
  - 2. Install and configure VMS software on all system-connected Workstation PCs.
  - 3. Set up web browser link and interface on remote PCs or mobile apps as requested by Owner's personnel.

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
  - 2. Pretesting:
    - a. Align and adjust system and pretest components, wiring, and functions to verify that they comply with requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable.
    - b. Verify operation of auto-iris lenses.
    - c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
    - d. Set sensitivity of motion detection.
    - e. Verify operation of control-station equipment.
  - 3. Operational Tests:
    - a. Perform operational system tests to verify that system complies with requirements. All devices shall be tested. Include all modes of system operation. Test equipment for proper operation in all functional modes.
    - b. Perform operational system tests only after all pretesting exercises are complete.
    - c. Operational system tests must be completed prior to Substantial Completion.
- C. Video surveillance system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean all system components, including camera housings, lenses, servers, equipment, and monitor screens.

### 3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

### 3.8 CLOSEOUT & DEMONSTRATION

- A. Provide Operations & Maintenance Manual to Owner's personnel in compliance with requirements.
- B. Train Owner's maintenance personnel to adjust, operate, and maintain security cameras and equipment.
  1. Provide multimedia recording of training session for Owner's future reference.
  2. Demonstrate all functionality and capability of security camera system.

END OF SECTION

## SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this section.
- B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
  - 1. Div 26 Electrical
  - 2. Div 21 Fire Suppression
  - 3. Div 23 Heating, Ventilating, and Air-Conditioning (HVAC)
- C. The system and all associated operations shall be in accordance with the following:
  - 1. Requirements of the following Model Building Code: IBC 2024 Edition.
  - 2. Requirements of the following Model Fire Code: IFC 2024 Edition.
  - 3. Requirements of the following Model Mechanical Code: IMC 2024 Edition.
  - 4. NFPA 72, National Fire Alarm Code, 2022 Edition.
  - 5. NFPA 70, National Electrical Code, 2023 Edition.
  - 6. Elevator Code, ASME A17.1, 2019 Edition.

#### 1.2 SUMMARY

- A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
  - 1. Fire alarm system detection and notification operations.
  - 2. Control and monitoring of elevators, door hold-open devices, air handling units, fire/smoke dampers, fire suppression systems, and other equipment as indicated in the drawings and specifications.
  - 3. One-way supervised automatic voice alarm operations.

#### 1.3 DEFINITIONS

- A. ADA: Americans with Disabilities Act



- B. AHJ: Authority Having Jurisdiction
- C. ANSI: American National Standards Institute
- D. ASME: American Society of Mechanical Engineers
- E. FACU: Fire Alarm Control Unit
- F. FM: Factory Mutual
- G. IBC: International Building Code
- H. ICC: International Code Council
- I. IDC: Initiating Device Circuit
- J. IEEE: Institute of Electrical and Electronic Engineers
- K. IFC: International Fire Code
- L. IMC: International Mechanical Code
- M. IRI: Industrial Risk Insurers
- N. LED: Light-emitting diode.
- O. NAC: Notification Appliance Circuit
- P. NFPA: National Fire Protection Association
- Q. NICET: National Institute for Certification in Engineering Technologies.
- R. RAC: Releasing Appliance Circuit
- S. SLC: Signaling Line Circuit
- T. UL: Underwriters Laboratories
- U. ULC: Underwriters Laboratories, Canada

#### 1.4 SCOPE OF WORK

- A. Design, furnish, install and commission a new digital addressable voice evacuation fire alarm system as indicated on drawings and as required by applicable codes for the new High School.

## 1.5 SYSTEM DESCRIPTION

- A. General: Provide a complete, non-coded addressable microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.
- B. Power Requirements
  - 1. The control unit shall receive AC power via a dedicated circuit breaker.
  - 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
  - 3. All circuits requiring system-operating power shall be 24 VDC nominal voltage and shall be individually fused at the control unit.
  - 4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
  - 5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
  - 6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
  - 7. The system shall support 100% of addressable initiating devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
  - 8. Loss of primary power shall sound a trouble signal at the FACU. FACU shall indicate when the system is operating on an alternate power supply.
- C. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary.
  - 1. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
  - 2. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
  - 3. Panels shall be capable of full system operation during new site specific configuration download, master exec downloads, and slave exec downloads.
  - 4. Remote panel site-specific software and executive firmware downloads shall be capable of being performed over proprietary fire alarm network communications, and via TCP/IP Ethernet network communications. Ethernet access to a fire alarm panel via a customer's LAN/WAN connection shall be capable of providing access

only to authenticated users through a cryptographically authenticated and secure SSL tunnel.

5. Panels shall automatically store all program changes to the panel's non-volatile memory each time a new program is downloaded. Panels shall be capable of storing the active site-specific configuration program and no less than 9 previous revisions in reserve. A compare utility program shall also be available to authorized users to compare any two of the saved programs. The compare utility shall provide a deviation report highlighting the changes between the two compared programs.
  6. Panels shall provide electronic file storage with a means to retrieve a record copy of the site-specific software and up to 9 previous revisions. Sufficient file storage shall be provided for other related system documentation such as record drawings, record of completion, owner's manuals, testing and maintenance records, etc.
  7. The media used to store the record copy of site-specific software and other related system documentation shall be electrically supervised. If the media is removed a trouble shall be reported on the fire alarm control unit.
- D. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- E. Recording of Events: The system shall be capable of recording all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout shall differentiate alarm signals from all other printed indications.
- F. Wiring/Signal Transmission:
1. Transmission shall be hard-wired using separate individual circuits for each zone of alarm operation, as required or addressable signal transmission, dedicated to fire alarm service only.
  2. System connections for initiating device circuits shall Class B, signaling line circuits shall be Class B and notification appliance circuits shall be Class B.
  3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACU. Provide a distinctive indicating audible tone and alphanumeric annunciation.
  4. Constant Supervision Audio: When provided, audio notification appliance circuits shall be supervised during standby by monitoring for DC continuity to end-of-line resistors.
- G. Required Functions: The following are required system functions and operating features:
1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.

2. Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACU after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
3. Transmission to an approved Supervising Station: Automatically route alarm, supervisory, and trouble signals to an approved supervising station service provider, under another contract.
4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACU and the remote annunciator, indicating the type of device, the operational state of the device (i.e. alarm, trouble or supervisory) and shall display the custom label associated with the device.
5. Selective Alarm: A system alarm shall include:
  - a. Indication of alarm condition at the FACU and the annunciator(s).
  - b. Identification of the device /zone that is the source of the alarm at the FACU and the annunciator(s).
  - c. Operation of audible and visible notification appliances until silenced at FACU.
  - d. Closing doors normally held open by magnetic door holders.
  - e. Unlocking designated doors.
  - f. Shutting down supply and return fans serving zone where alarm is initiated.
  - g. Closing smoke dampers on system serving zone where alarm is initiated.
  - h. Transmission of signal to the supervising station.
  - i. Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ANSI/ASME A17.1 / CSA B44, Safety Code for Elevators and Escalators, when specified detectors or sensors are activated, as appropriate.
6. Supervisory Operations: Upon activation of a supervisory device such as a low air pressure switch and tamper switch, the system shall operate as follows:
  - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
  - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
  - c. Record the event in the FACU historical log.
  - d. Transmission of supervisory signal to the supervising station.
  - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.
8. Priority Two Operations: Upon activation of a priority two condition, the system shall operate as follows:

- a. Activate the system priority two audible signal and illuminate the LED at the control unit and the remote annunciator.
- b. Pressing the Priority 2 Acknowledge Key will silence the audible signal while maintaining the Priority 2 LED "on" indicating off-normal condition.
- c. Record the event in the FACU historical log.
- d. Transmission of priority two signal to the supervising station.
- e. Restoring the condition shall cause the Priority 2 LED to clear and restore the system to normal.

#### 9. System Reset

- a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
  - b. Should an alarm condition continue, the system will remain in an alarmed state.
10. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
11. WALKTEST: The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
- a. The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
  - b. Control relay functions associated with one of the 8 testing groups shall be bypassed.
  - c. The control unit shall indicate a trouble condition.
  - d. The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
  - e. The unit shall automatically reset itself after signaling is complete.
  - f. Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
- 1) Any device which is activated during the time that Walktest is enabled, but is not within the group under test shall immediately cause a normal alarm sequence to commence as if the system was not under any testing sequence.

12. Install Mode: The system shall provide the capability to group all non-commissioned points and devices into a single "Install Mode" trouble condition allowing an operator to clearly identify event activations from commissioned points and devices in occupied areas.

- a. It shall be possible to individually remove points from Install Mode as required for phased system commissioning.
- b. It shall be possible to retrieve an Install Mode report listing that includes a list of all points assigned to the Install Mode. Panels not having an install mode shall be reprogrammed to remove any non-commissioned points and devices.

13. Module Distribution:

- a. The fire alarm control unit shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Class B supervised serial communications channel (SLC):

- 1) Initiating Device Circuits
- 2) Notification Appliance Circuits
- 3) Auxiliary Control Circuits
- 4) Graphic Annunciator LED/Switch Control Modules

- a) In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.

- 5) Initiating Device Signaling Line Circuits
- 6) Notification Appliance Signaling Line Circuits
- 7) Power Supplies
- 8) Voice System Amplifiers

H. Analog Smoke Sensors:

- 1. Monitoring: FACU shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
- 2. Environmental Compensation: The FACU shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
- 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACU.
- 4. Sensitivity Testing Reports: The FACU shall provide sensor reports that meet NFPA 72 calibrated test method requirements.

- a. Reports shall be capable of being printed for annual recording and logging of the calibration maintenance schedule.
  - b. Where required, reports shall be accessible remotely through:
    - 1) A Fire Panel Internet Interface using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3. The Fire Panel Internet Interface shall be capable of automatically scheduling email reports to individual user accounts on a weekly, bi-weekly, or monthly schedule
5. The FACU shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACU as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system. If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACU and subsequently a system trouble is reported to the Supervising Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
  6. The FACU shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
  7. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.
  8. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
  9. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

I. Fire Suppression Monitoring:

1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
3. Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device has been activated on the initiating zone.

4. Kitchen hood suppression system: Activation of the kitchen hood suppression system shall initiate general alarm operations.
- J. Audible Alarm Notification: By voice evacuation speakers.
1. Automatic Voice Evacuation Sequence:
    - a. The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the "Alarm Silence" switch is activated.
    - b. All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.
- K. Speaker: Speaker notification appliances shall be listed to UL 1480.
1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
  2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
  3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
- L. Manual Voice Paging
1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
  2. The control unit operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
  3. Total building paging shall be accomplished by the means of an "All Call" switch.
  4. Remote microphone/Local operator console shall include LED switch modules for selection of prerecorded messages and paging zones.
  5. Local operator console shall be located at the FACU and the primary remote annunciator location and as indicated on the drawings.
- M. Constant Supervision of Non-Alarm Audio Functions
1. When required, the system shall be configured to allow Non-Alarm Audio (NAA) functions such as background music or general/public address paging.
  2. During NAA operation, the speaker circuit shall be electrically supervised to provide continuous monitoring of the speaker circuit.
  3. During an alarm condition, supervision shall be disabled and alarm signals delivered to speakers.



N. Addressable Notification Appliances (Applies only if addressable notification is provided):

1. Monitoring: The FACU shall monitor individual addressable notification appliances for status, condition, type of appliance, and configured appliance settings. A fault in any individual appliance shall automatically report a trouble condition on the FACU.
2. Individual Appliance Custom Label: Each addressable appliance shall have its own 40 character custom label to identify the location of the appliance and to aid in troubleshooting fault conditions.
3. Individual Appliance Information Display:
  - a. The FACU shall be capable of calling up detailed information for each addressable appliance including the appliance location, status, condition, type of appliance, and configured appliance settings.
4. Programmable Appliance Settings:
  - a. The selectable operation of each addressable notification appliance shall be capable of being configured by the FACU without having to replace or remove the appliance from the wall or ceiling.
5. Programmable Notification Zones:
  - a. Changing the notification zone assigned to a notification appliance shall be configurable by the FACU and shall not require additional circuits or wiring.

## 1.6 SUBMITTALS

- A. Final layout and selection of devices shall be by contractor delegated design submittal.
- B. Submittals shall be approved by the AHJ prior to starting installation of any devices or wiring.
- C. Shop drawings shall be prepared by NICET Level IV.
- D. General: Submit the following according to Conditions of Contract.
  1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
  2. Wiring diagrams from manufacturer.
  3. Shop drawings showing system details including location of FACU, all devices, circuiting and details of annunciator.

4. Comprehensive fire alarm riser diagram (single-line) for plan approval, detailing the interconnection of all devices to the control panel. This diagram must show device types, circuit types (Class A/B), zone identifications, and wire types. Provide floor plans, equipment datasheets, and battery calculations.
  5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
  6. Operating instructions for FACU.
  7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
  8. Product certification signed by a certified representative of the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
  9. Record of field tests of system.
- E. Submittals shall comply with the recommendations and requirements of IBC and NFPA 72.
- F. Submit qualification data for installing contractor, technicians, and shop drawing preparer.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A NICET Level II (minimum) factory trained installer is to perform the work of this section.
- B. Contractor and installers shall be licensed by the State of Wyoming to sell, service, and install fire alarm systems.
- C. Each and every item of the Fire Alarm System shall be listed under the appropriate category by a Nationally Recognized Testing Laboratory and shall bear the respective "NRTL" label.

## 1.8 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. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## 1.9 MAINTENANCE SERVICE

- A. Warranty Maintenance Service: Provide maintenance of fire alarm systems and equipment for a period of 24 months, using factory-authorized service representatives
- B. Basic Services: Routine maintenance visits on an "as needed" basis at times scheduled with the Owner. Respond to service calls within 24 hours of notification of system trouble either by customer visit or other customer contact as necessary. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
- C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
- D. Maintenance Service Contract: No later than 60 days prior to the expiration of the warranty maintenance services, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. As an option with this proposal, deliver to the Owner a proposal to provide scheduled inspection and testing services for a one-year term. Owner will be under no obligation to accept maintenance service contract proposal or inspection and testing proposal.

## 1.10 EXTRA MATERIALS

- A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
  1. Manual Stations: Furnish 1 manual station.
  2. Notification Appliances: Furnish quantity equal to 1 percent of each type and number of units installed, but not less than one of each type.
  3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 1 percent of each type and number of units installed but not less than one of each type.
  4. Detector or Sensor Bases: Furnish quantity equal to 1 percent of each type and number of units installed but not less than one of each type.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

- A. Manufacturers: Subject to compliance with the requirements of this specification, provide products by one of the following:
  - 1. Notifier.
- B. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.
- C. Alternate products must be submitted to the Engineer two weeks prior to bid for approval. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
- D. The equipment and service provider shall be a nationally recognized company specializing in fire alarm and detection systems. This provider shall employ factory trained and NICET Level II certified technicians and shall maintain a service organization within 200 miles of this project location. The equipment and service provider shall have a minimum of 10 years experience in the fire protective signaling systems industry.

### 2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Duct smoke detectors.
  - 5. Verified automatic alarm operation of smoke detectors.
  - 6. Automatic sprinkler system water flow.
  - 7. Heat detectors in elevator shaft.
  - 8. Fire-extinguishing system operation.
  - 9. Carbon Monoxide Sensors.
- B. Fire-alarm signal shall initiate the following actions as required:
  - 1. Continuously operate alarm notification appliances.
  - 2. Identify alarm at fire-alarm control unit and remote annunciators.
  - 3. Transmit an alarm signal to the remote alarm receiving station.
  - 4. Unlock electric door locks in designated egress paths.
  - 5. Release fire and smoke doors held open by magnetic door holders.
  - 6. Activate voice/alarm communication system.
  - 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.

8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
  9. Recall elevators to primary or alternate recall floors.
  10. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
  2. Low-air-pressure switch of a dry-pipe sprinkler system.
  3. Elevator shunt-trip supervision.
  4. Elevator power monitoring.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
  2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  3. Loss of primary power at fire-alarm control unit.
  4. Ground or a single break in fire-alarm control unit internal circuits.
  5. Abnormal AC voltage at fire-alarm control unit.
  6. Break in standby battery circuitry.
  7. Failure of battery charging.
  8. Abnormal position of any switch at fire-alarm control unit or annunciator.
  9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer where provided.

## 2.3 FIRE ALARM CONTROL UNIT (FACU)

- A. The following FACU hardware shall be provided:
1. Power Limited base panel with cabinet and door, 120 VAC input power.
  2. 3,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
  3. 2000 points of annunciation where one (1) point of annunciation equals:
    - a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
    - b. 1 LED on panel or 1 switch on panel.
  4. 9.5 Amp Power Supply minimum with temperature compensated, dual-rate battery charger capable of charging up to 110 Ah batteries without a separate external battery charger. Battery charger voltage and amperage values shall be accessible on the FACU LCD display. Optional cooling fan shall be available to increase base

power supply from 9.5 to 12.7 Amps. Optional expansion and back-up power supplies shall be available.

5. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
6. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
7. Three (3) circuit Class B Addressable Notification Appliance Signaling Line Circuits (SLCs) module.
  - a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 127 Notification Appliances per channel.
  - b. Wiring shall be 18 AWG to 14 AWG (minimum) unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
  - c. A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the FACU to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.
  - d. For systems that do not provide a constant voltage source at the FACU notification appliance field wiring terminal connections, the fire alarm contractor shall:
    - 1) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and
    - 2) Perform a complete functional test of all notification appliances under worst case secondary power conditions.
8. Three (3) circuit Class B Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive) module. The NAC end-of-line resistor value shall be programmable and selected from a wide range of resistance values.
  - a. NAC's shall be conventional reverse polarity operation and shall be for synchronized strobes and independent horn/strobe operation over two wires.
  - b. NACs shall be selectable as auxiliary power outputs derated to 2 A for continuous duty.
  - c. Strobe synchronization and audible cadence synchronization shall be across all panel NAC circuits. Systems that cannot provide listed synchronization across all panel NAC's shall not be acceptable.
9. Where required provide Intelligent Remote Battery Charger for charging up to 55Ah batteries.
10. The FACU shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.
11. Remote Unit Interface: supervised Class B (Style 4) or Class X (Style 7) serial communication channel for control and monitoring of remotely located annunciators and I/O panels.

12. Universal Communicator supporting POTS, Internet, and Cellular communications. Shall have multiple connectivity options and be configurable with a primary and secondary path. Paths can use any of the external connections; telephone line, cellular, or LAN Ethernet. Transmission format shall be based on ADEMCO Contact ID Alarm Communication Protocol.
- B. Cabinet: Lockable semi-recessed steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
- C. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
- D. Distributed Module Operation: FACU shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Class B supervised serial communications channel (SLC):
  1. Addressable Signaling Line Circuits
  2. Initiating Device Circuits
  3. Notification Appliance Circuits
  4. Auxiliary Control Circuits
  5. Annunciator LED/Switch Control Modules
    - a. In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.
6. Amplifiers, voice and telephone control circuits
- E. Voice Alarm: Provide an emergency communication system, integral with the FACU, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:
  1. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems." Amplifiers shall provide an onboard local mode temporal coded horn tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover. Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface. Each amplifier shall be capable of performing constant supervision for non-alarm audio functions such as background music and general paging.
  2. Dual alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by use of the central control microphone.

All announcements are made over dedicated, supervised communication lines. All risers shall support Class B wiring for each audio channel.

3. Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages. Provide supervised connections for master microphone and up to 5 remote microphones.
4. Status annunciator indicating the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.
5. When required, Redundant Voice Command Centers shall be capable of generating voice paging from more than one node in a network audio system.

## 2.4 ADDRESSABLE INITIATING

### A. ADDRESSABLE MANUAL PULL STATIONS

1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
2. Description: Addressable double-action type, red LEXAN. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units. Station shall be pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit. Break-glass or glass-rod stations are NOT permitted.
3. Provide with a front showing red LED showing that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the station LED shall be on steady.
4. Indoor Protective Shield: Where required, or as indicated on the drawings, provide a factory-fabricated, tamperproof, clear LEXAN enclosure shield and red frame that easily fits over manual pull stations which shall be hinged at the top to permit lifting for access to initiate a local alarm. Unit shall be NRTL listed. Lifting the cover shall actuate an integral battery-powered audible horn intended to discourage false-alarm operation. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

### B. ADDRESSABLE ANALOG SMOKE SENSORS

1. General Requirements for System Smoke Detectors:
  - a. Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
  - b. Factory Nameplate: Serial number and type identification.
  - c. Operating Voltage: 24 VDC, nominal and shall be two-wire type.



- d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
- e. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. Provide terminals in the fixed base for connection to building wiring. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit. Sensors shall include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACU. Sensor address shall be located in base to eliminate false addressing when replacing sensors. Integral Addressable Module shall be arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit. Each sensor base shall contain an integral visual-indicating LED that will flash to provide power-on status each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.][Quick Connect Arrangement: Photoelectric sensor and electronics in a single piece construction which shall twist-lock onto a mounting base that attaches to a standard electrical box. Provide terminals in the fixed base for connection to building wiring. Sensors shall include an internal communication transmitter and receiver in the sensor having a unique identification and capability for status reporting to the FACU. Integral Addressable Module shall be arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit. Each sensor shall contain an integral visual-indicating LED that will flash to provide power-on status each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor LED shall be on steady. Sensor and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
- f. Each sensor base shall contain a magnetically actuated test switch to provide for easy pre-certification alarm testing at the sensor location.
- g. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
- h. Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit. Provide multiple levels of detection sensitivity for each sensor.

- i. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACU.
- j. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI. Removal of the sensor head for cleaning shall not require the setting of addresses.
- k. Bases: CO Sensor, relay output, sounder and isolator bases shall be supported alternatives to the standard base.

## 2. Addressable Sensor Bases

- a. Standard base - Twist lock addressable base with address selection DIP switch accessible from front with sensor removed. Integral red LED for power-on (pulsing), or alarm or trouble (steady on). Locking anti-tamper design mounts on standard outlet box.
- b. Sensor Base with remote device connection - All standard base features with wired connection for either a Remote LED alarm indicator or remote relay (relay is unsupervised and requires separate 24VDC)
- c. Supervised Relay Bases - All standard base features and shall be available in either a 4-Wire Sensor Base to use with remote or locally mounted relay; requires separate 24 VDC, or as a 2-Wire Sensor Base to use with remote or locally mounted relay; no separate power required. Supervised relay operation shall be programmable and shall be manually operated from control panel.
- d. Sensor base with built-in electronic alarm sounder - All standard base features and piezoelectric sounder shall provide high output (88 dBA) with low current requirements (20 mA). Sounder shall be synchronized via SLC communications or by the NAC if NAC powered, sounder shall operation shall be programmable and shall be manually operated from control panel.

## C. ADDRESSABLE DUCT SMOKE SENSOR

- 1. Standard Addressable Duct Smoke Sensor Unit. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied.
  - a. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACU.
  - b. Provide separate addressable relay modules for control functions. Relays shall be mounted within 3 feet of HVAC control circuit.
  - c. Duct Housing shall provide a magnetic test area and Red sensor status LED and Duct Housing shall provide a relay control Yellow LED trouble indicator.
  - d. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.

- e. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
- f. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
- g. Each duct smoke sensor shall be provided with a Remote Test Station with an alarm LED and test switch.
- h. Provide keyed remote test switch with LED for each duct smoke detector.
- i. Where indicated provide a NEMA 4X weatherproof duct housing enclosure that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.

#### D. ADDRESSABLE HEAT SENSORS

- 1. General Requirements for Heat Detectors: Comply with UL 521.
- 2. Thermal Sensor Combination type: Fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; Actuated by either a selected fixed temperature or a rate of rise that exceeds a preset amount per minute unless otherwise indicated.
- 3. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag. Selectable rate compensated, fixed temperature sensing with or without rate-of-rise operation.
- 4. Mounting: Twist-lock base interchangeable with smoke-sensor heads.
- 5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- 6. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F, 155-deg F or 190-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACU for either 15-deg F or 20-deg F per minute.
- 7. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.
- 8. Unless otherwise indicated, sensors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for temperature by fire-alarm control unit.
  - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
  - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135-deg F, 155-deg F or 190-deg F.

#### E. ADDRESSABLE CO SENSOR

1. Addressable CO Sensor

- a. The CO Sensor shall be an addressable carbon monoxide (CO) sensing module providing both CO toxic gas detection and enhanced fire detection, and shall be listed to UL 268, Smoke Detectors for Fire Alarm Signaling Systems and UL 2075, Gas and Vapor Detectors and Sensors; allowing systems to be listed to UL 2034, Single and Multiple Station Carbon Monoxide Alarms.
- b. The CO Sensor shall include CO sensor element mounted in the sensor base which can be easily replaced without replacing the complete sensor base assembly.
- c. The CO Sensor base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
- d. The CO Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.
- e. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
- f. The CO Sensor shall provide a 10 year life expectancy before replacement is necessary or required.
- g. The CO Sensor base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.

F. ADDRESSABLE CIRCUIT INTERFACE MODULES

1. Addressable Circuit Interface Modules: Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of AHU systems.
2. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box or be cabinet mounted using appropriate mounting to allow quick replacement. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
3. Provide individual input modules for each initiating device. A single input module shall not supervise multiple initiating devices.
4. There shall be the following types of modules:
  - a. Type 1: Monitor Circuit Interface Module:
    - 1) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. This module will communicate status (normal, alarm, trouble) to the FACU.
    - 2) For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power

protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACU.

b. Type 2: Line Powered Monitor Circuit Interface Module

- 1) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACU.
- 2) This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

c. Type 3: Single Address Multi-Point Interface Modules

- 1) This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
- 2) This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
- 3) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

d. Type 4: Line Powered Control Circuit Interface Module

- 1) This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

e. Type 5: 4-20 mA Analog Monitor Circuit Interface Module

- 1) This module shall communicate the status of a compatible 4-20 mA sensor to the FACU. The FACU shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

5. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACU. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

## 2.5 ADDRESSABLE NOTIFICATION

### A. ADDRESSABLE ALARM NOTIFICATION APPLIANCES

1. Addressable Notification Appliances (if used): Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).
  - a. Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.
  - b. All Notification Appliances shall operate as a completely independent device allowing for specific location alerting of both fire alarm and Mass Notification functions. Each visible device (both clear fire alarm and amber mass notification) shall be capable of operating on multiple notification zones or completely separate from all other notification devices, this allows "On the fly" program operation changes for Mass Notification alerting and fire alarm notification.
  - c. All Notification Appliances shall operate as a completely independent device allowing for appliances in handicap accessible rooms and other locations to operate on the same SLC and to activate individually based on an alarm condition in a room or as part of a general alarm condition where all appliances activate together.
  - d. Individual Notification Appliances shall be able to be grouped into zones (or operational groups) by central programming at the main fire alarm control unit.
  - e. Notification Appliances shall provide for "unobtrusive" testing. Each Notification Appliance shall be tested for audible and visible operation on an individual basis at the device or from the main fire alarm control unit, allowing for minimal invasive impact.
  - f. Class B notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 127 addresses can be supported on a single channel.
  - g. Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the

- channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.
- h. Each addressable notification appliance shall have electrical test point access without removing the device cover.
  - i. Both wall mount and ceiling mount devices shall be available along with weatherproof devices.
2. Addressable Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O device shall consist of a xenon flash tube and associated lens/reflector system, cover and mounting plate. For ease of installation the mounting plate shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. When the appliance is connected to an active circuit, the front cover of the appliance shall be removable without causing a trouble indication on the fire alarm control unit. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The V/O appliance shall be provided with multiple minimum flash intensities of 15cd, 30cd, 75cd, 110cd, 135cd and 185cd. The Candela levels shall be settable from the fire alarm control unit or by using a hardware selector on the appliance.
3. Standard Speaker: Speaker notification appliances shall be listed to UL 1480.
- a. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted / shielded wire.
  - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
  - c. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
  - d. The speaker shall install directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.
4. Hybrid Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.
- a. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
  - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 82 dBA at 10 feet.

- c. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
  - d. The S/V installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.
5. Addressable Speaker: Addressable Speaker notification appliances shall be listed to UL 1480. Individual device level supervision and activation control shall be provided by the fire alarm control unit.
- a. Speakers shall be individually powered, addressed, and controlled from a compatible fire alarm control unit Signaling Line Circuit (SLC) using Unshielded Twisted Pair (UTP) cable and T-taps shall be allowed for Class B installation reducing wiring costs and wiring distances. Shielded cable shall not be required.
  - b. Speakers shall provide for Fire Alarm and General Signaling functionality in a single unit, eliminating additional devices. Device "Self-Test" shall be supported by a compatible fire alarm control unit and shall be UL listed and NFPA 72 compliant. Speakers shall be UL listed to provide a 520Hz audio tone in compliance with NFPA 72 for sleeping areas.
  - c. The speaker audio shall be provided by a standard 25VRMS or 70.7VRMS audio circuit using Unshielded Twisted Pair (UTP) cable and T-taps shall be allowed for Class B installation reducing wiring costs and wiring distances. Supervision of this circuit shall be provided by the addressable speaker. Shielded cable shall not be required.
  - d. Speaker power taps shall be at a minimum of 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker shall have a minimum UL rated sound pressure level of 86dBA at 10 feet for the Standard Output version and 84dBA at 10 feet for the High Fidelity version.
  - e. Speakers shall be available in either "Standard Output" with a minimum frequency response of 400 to 4000 Hz or in "High Fidelity Output" with a minimum frequency response of 200 to 10,000 Hz. Standard Output speakers shall use a multi-tapped speaker for audio/tone notification.
  - f. Wall mount appliances shall be available in White and Red and ceiling mount appliances shall be available in White, Red, and Black. Labeling shall be available as either "FIRE", "ALERT" or no labeling.
  - g. The speaker shall install directly to a 4" square, 2 1/8" deep electrical box. Extensions for these boxes shall not be required. Units shall be modular in design to allow for easy installation and for easy changing of device color and labeling.
6. Addressable Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker shall operate on a 25VRMS or 70.7VRMS NAC.



- a. Operational functions and features of Addressable Speaker above shall apply to this section. Operational functions and features of Addressable Strobe above shall apply to this section.
- b. Wall mount appliances shall be available in White and Red and ceiling mount appliances shall be available in White, Red, and Black. Labeling shall be available as either "FIRE", "ALERT" or no labeling.
- c. The speaker shall install directly to a 4" square, 2 1/8" deep electrical box. Extensions for these boxes shall not be required. Units shall be modular in design to allow for easy installation and for easy changing of device color and labeling

## B. ADDRESSABLE APPLIANCE SLC REPEATER

- 1. Addressable Repeater (if used) shall supervise channel (SLC) wiring and communicate with and control addressable notification appliances. The Repeater shall be a stand-alone panel capable of powering one (1) NAC SLC. The channel (SLC) shall be rated for 3 amps and support up to 127 addresses. Power and communication for the notification appliances shall be provided on the same pair of wires. It shall be possible to program the High/Low setting of the audible (horn) appliances by channel from the addressable controller.
  - a. The Repeater shall provide a constant voltage output to ensure NAC current and voltage do not vary whether the panel is operating on AC or battery. The output voltage during alarm conditions shall be 29 VRMS.
  - b. Addressable SLC notification appliance circuits shall be Class B.
  - c. For Class B circuits, the Repeater shall support up to 4 Class B branches directly at its output terminals for one SLC.
  - d. The internal power supply and battery charger shall be capable of charging up two 12.7 Ah batteries internally mounted or 25Ah batteries mounted in an external cabinet.
  - e. The Repeater panel can be mounted close to the host fire alarm control unit or remotely.
  - f. The Repeater status shall be communicated to the host fire alarm control unit and locally indicated.
  - g. A 200mA auxiliary output shall be available
  - h. The Repeater shall be listed to UL 864

## 2.6 CONVENTIONAL NOTIFICATION

### A. STANDARD ALARM NOTIFICATION APPLIANCES (if used)

- 1. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with

different minimum flash intensities of 15cd, 30cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

2. Weatherproof Audible/Visible: Weatherproof horn/strobe shall be UL 464 and UL 1971 listed for indoor applications with strobe intensity selectable as 15, 60, or 75 cd or UL 1638 listed for outdoor applications with strobe rated at 75 cd (WP75). The appliances shall be acceptable for indoor and outdoor, extended temperature and extended humidity applications. The A/V device shall consist of a xenon flash tube and associated lens/reflector system, weatherproof cover and weatherproof mounting box. The Candela levels shall be selectable by using a hardware selector on the appliance. The Horn shall support Temporal Code 3, March Time (20, 60, or 120 BPM), Continuous, and Temporal Code 4 coding patterns. The horn shall have a minimum sound pressure level of 79 dBA for coded operation at 24 VDC.
3. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480.
  - a. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC.
  - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
  - c. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
  - d. The S/V installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.
4. Speaker: Speaker notification appliances shall be listed to UL 1480.
  - a. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted / shielded wire.
  - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
  - c. The Speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
  - d. The Speaker installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.
5. Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz and operates horns with a Temporal Code Pattern operation. The circuit shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.
6. Accessories: The contractor shall furnish any necessary accessories.

B. NAC Remote Power Supply (if used)

1. The SLC NAC Remote Power Supply panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class B rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits.
2. The internal power supply and battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
3. The NAC remote power supply panel may be mounted close to the host control unit or can be remotely located. The SLC Addressable NAC Remote Power Supply Panel when connected to an addressable panel shall connect to the host panel via an SLC communications channel. Via the SLC channel each output NAC can be individually controlled for general alarm or selective area notification.
4. For SLC connected NAC remote power supply panel up to five panels can be connected on a single SLC channel.
5. When connected to a conventional (non-addressable panel) one or two standard notification appliance circuits from the main control unit may be used to activate all the circuits on the NAC Remote Power Supply panel.
6. Alarms from the host fire alarm control unit shall signal the NAC Remote Power Supply panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.

## 2.7 MAGNETIC DOOR HOLDERS

- A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.
- B. Material and Finish: Match door hardware.

## 2.8 REMOTE LCD ANNUNCIATOR

- A. Provide a remote LCD Annunciator with the same "look and feel" as the FACU operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys; Status LEDs and LCD Display as the FACU.
- B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
- C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.
- D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

- E. The LCD shall display the following information relative to the abnormal condition of a point in the system:
  - 1. 40 character custom location label.
  - 2. Type of device (e.g., smoke, pull station, waterflow).
  - 3. Point status (e.g., alarm, trouble).
- F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACU.
- G. Provide semi-recessed enclosure that will house the Remote Annunciator and the Local Operator Console in a single enclosure.

## 2.9 LOCAL OPERATION CONSOLE

- A. The local operating console shall be installed in the same enclosure as the following.
  - 1. FACU, mounted within the same cabinet with key lock.
  - 2. Remote annunciator, mounted within the same cabinet with key lock.
- B. Local operating console requirements:
  - 1. Description: Dedicated, paging microphone links to the FACU that provides talk capability over the Notification Appliances.
  - 2. Amplifiers throughout the facility to support the notification devices to accommodate zone paging.
  - 3. Performance Criteria:
    - a. Regulatory Requirements:
      - 1) NFPA 72.
    - b. General Characteristics:
    - c. Audible Pulse and Tone Generator, and High-Intensity Lamp.
    - d. Paging microphone or telephone handset with push to talk feature.

## 2.10 DACT/IP/CELLULAR COMMUNICATOR TRANSMITTER

- A. DACT/IP/Cellular communicator transmitter shall be listed to UL 864 for Central Station Service and be acceptable for use by the remote or central station.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for, or connected via TCP/IP or Cellular to a remote or central station. When contact is made with the remote or central station, signals shall be transmitted. If connecting by POTS and service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter

shall automatically report telephone service restoration to the remote or central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal. If service is by TCP/IP or Cellular and connection is lost, transmitter shall initiate the local trouble signal and a loss of connection shall be indicated at the central station.

- C. Local functions of the DACT/IP/Cellular communicator transmitter shall include the following:
  - 1. Configurable with a primary and secondary path.
  - 2. Paths can use any of the external connections, telephone line, cellular, or LAN Ethernet connections.
  - 3. Communications failure with the remote or central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
  - 1. Address of the alarm-initiating device.
  - 2. Address of the supervisory signal.
  - 3. Address or loss of power.
  - 4. Low battery.
  - 5. Abnormal test signal.
  - 6. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Constant connection supervision and detects failures within 90 seconds for IP/Cellular connection.

## 2.11 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 15 minutes.

## 2.12 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
  - 1. Factory fabricated and furnished by manufacturer of device.
  - 2. Finish: Paint of color to match the protected device.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Installation personnel shall be licensed, qualified and experienced in the installation, inspection, and testing of fire alarm systems. Qualifications shall include all of the following:
  - 1. Factory trained and certified.
  - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified. Level II minimum.
  - 3. Licensed by the State of Wyoming.

### 3.2 EQUIPMENT INSTALLATION

- A. Design, furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, Ethernet drops, and all other necessary material for a complete operating system.
- B. Do not remove smoke detector factory covers until all construction and clean up is complete.
- C. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
- D. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
- E. Install manual station, wall mounted audible and visual notification appliances in as indicated on the drawing and in accordance with NFPA 72.
- F. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- G. Make conduit and wiring connections to devices and control units.
- H. Automatic Detector Installation: Conform to NFPA 72.
- I. Ethernet Drop: A standard RJ-45 Ethernet connection to the owner's Ethernet network shall be provided at each fire alarm control unit as part of the contract.

### 3.3 PREPARATION

- A. Coordinate work of this Section with other affected work.

### 3.4 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.
  - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) 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. Air handling units over 2,000 c.f.m.
  - 3. Alarm monitoring of kitchen hood fire suppression system.
  - 4. Connections to elevator recall, shunt-trip, power and fire hat system and components.
  - 5. Alarm monitoring for each waterflow and alarm pressure switch.
  - 6. Supervisory connections at valve supervisory switches.
  - 7. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

### 3.5 WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. All fire alarm cabling ran in return-air handling spaces shall be plenum rated FPLP. Wiring may be installed free-air where concealed in accessible ceiling spaces. Wiring shall be installed in conduit in walls and hard-lid ceiling spaces. Provide conduit stubs/sleeves to nearest accessible ceiling space. In unfinished areas, cabling shall be installed in conduit up to 96" above finished floor and as required to protect cabling from mechanical damage in accordance with NEC. Exposed conduit in unfinished areas shall be red. All free-air cabling shall be neatly bundled, installed parallel and perpendicular to the structure, and supported in accordance with NEC and at not more than 5' on center.
- C. All conduit shall be EMT,  $\frac{3}{4}$ " minimum.
- D. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- E. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use different color codes for different circuit types.

F. Paint fire alarm system junction boxes and covers red.

G. Ethernet Circuits:

1. Ethernet circuits shall be provided to the Fire Alarm Control Unit as shown on the plans.
2. Where a dedicated Fire Alarm Ethernet LAN is specified only Agency Listed Fire Alarm Ethernet hardware shall be installed.
3. The electrical contractor shall coordinate and ensure proper Ethernet connections occur at the fire alarm control unit prior to system turnover.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Label each field device with it's associated address or designator. Labels shall match those indicated on approved as-built drawings. Label monitor and control modules with functions. Provide ½" labels from commercially available label printer.
- C. Label all control units requiring 120VAC primary power with the associated panel and circuit number.
- D. Install framed instructions in a location visible from fire-alarm control unit.

### 3.7 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100.

### 3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Qualifications shall include all of the following:
  1. Factory trained and certified.
  2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified. Level II minimum.
  3. Licensed by the State of Wyoming.
- C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.



D. Inspection:

1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

E. Acceptance Operational Tests:

1. Perform operational system tests to verify conformance with specifications:
  - a. Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the Fire Alarm System installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test Supervising Station Signal Transmitter. Coordinate testing with Supervising Station monitoring firm/entity.
  - b. Test each Notification Appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
  - c. Test Fire Alarm Control Unit and Remote Annunciator.
2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.

H. Final Test, Record of Completion, and Certificate of Occupancy:

1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

### 3.9 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to two visits to the site for this purpose.

### 3.10 TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
  - 1. Train Owner's maintenance personnel and staff in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system.
  - 2. Training shall be provided on 2 separate days acceptable to the owner. Each training session shall be a minimum of 2 hours'.
  - 3. Schedule training with the Owner at least fourteen days in advance of the proposed training dates.

END OF SECTION 283111

## SECTION 28 48 00 - AREA OF RESCUE ASSISTANCE SYSTEMS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Two-way emergency communications systems for area of rescue assistance.
- B. Related Requirements:
  - 1. Section 26 05 19 "Low-Voltage Electrical Power Conductors and cable" for installation wiring and terminations.
  - 2. Section 26 05 29 "Hangars and Supports for Electrical Systems for supports for fire-alarm systems.
  - 3. Section 26 05 33 "Conduits for Electrical Systems" for raceways for fire-alarm systems.

#### 1.02 DEFINITIONS

- A. ARAS: Area of rescue assistance system.
- B. PES: Public emergency service.

#### 1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Coordination Meeting(s): For emergency communications systems. Conduct meeting(s) at Project site before rough-in installation.
- B. Coordinate power connection requirements with the electrical contractor.
- C. Coordinate 3<sup>rd</sup> part monitoring connection requirements with The District.

#### 1.04 ACTION SUBMITTALS

- A. Product Data:
  - 1. Two-Way Emergency Communications Systems for "Area of Rescue Assistance":
    - a. Master control station.
    - b. Remote communications stations.
    - c. Monitoring agreement for 1 year of service monitoring that will start after the 1<sup>st</sup> year of monitoring service that shall be included in the project.
- B. Shop Drawings:
  - 1. Project general notes. Include description of system operation.
  - 2. Two-Way Emergency Communications Systems for Rescue Assistance:
    - a. Device layout.
    - b. Block diagrams and cable/conduit routing.
    - c. Pathway class and survivability identification.
    - d. System communications details.
    - e. System sequence of operations.
    - f. System mounting details.

- g. Secondary power calculations and battery sizing.
- C. Certificates:
  - 1. Certification from each system vendor that equipment and components are compatible and represent a complete system in accordance with NFPA 72, NFPA 1221, and specified requirements.
  - 2. Provide test inspection report indicating system proper operation.
- D. Field Quality-Control Submittals:
  - 1. Field quality-control reports.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
  - 1. Installation instructions for two-way emergency communications systems for rescue assistance.
  - 2. Recommended tests and inspections for two-way emergency communications systems for rescue assistance.
- B. System Record of Inspection and Testing: Record copy of completed system acceptance testing.
- C. Sample warranties.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Warranty documentation.
- B. Product data of each component provided with specific part numbers on each item provided.
- C. Operation and programming instructions.
- D. As-built drawings showing device locations and interconnecting cabling diagrams.

#### 1.07 REGULATORY AGENCY APPROVALS

- A. Submittals for emergency communications systems require action by Architect prior to submitting for approval by authorities having jurisdiction.

#### 1.08 WARRANTY FOR EMERGENCY RESPONSE SYSTEMS

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
  - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

## 1.09 WARRANTY FOR BATTERIES

- A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agree to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

## 1.10 MONITORING SERVICE AGREEMENT

- A. One year of monitoring service shall be included in the project cost that shall begin on the date of substantial completion.

## PART 2 - PRODUCTS

### 2.01 TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS FOR RESCUE ASSISTANCE

- A. Description: This category includes equipment for providing two-way emergency voice communication for areas of elevator landings, and occupant evacuation elevator lobbies in accordance with NFPA 72.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:
  - 1. Rath Janus.
  - 2. Substitution shall be submitted for approval to the Architect 10 day prior to bid. Approved substitutions will be included in the addendum.
- C. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    - b. Unless otherwise indicated in Contract Documents, products must comply with NFPA 1, NFPA 70, NFPA 72, NFPA 101, ICC IBC, and local regulations enforced by authorities having jurisdiction.
  - 2. Listing Criteria: UL 2525 and NFPA 72.
- D. General Characteristics:
  - 1. Master Control Station: Mount in Lobby 100 to provide power, supervision, and control for two-way emergency communications systems for rescue assistance.
    - a. Communicate between master control station and remote communications stations.
    - b. Annunciate visual and audible signal at master control station when remote call is placed.
    - c. Silence audible signal when master control station is answered and remote call is acknowledged.
    - d. Display identification for location of remote communications stations in building.
  - 2. Remote Communications Station at elevators: Stainless steel-plate mounted station with hands-free, two-way communication.
  - 3. Auto Phone Dialer: 2100-LTEGSM4 4G Cellular Gateway.
  - 4. Power Supply: 120 volt supply power with internal transformers as required for system voltage including batteries, automatic float-charge battery charger, and automatic transfer switch.
  - 5. Pathway Survivability:
    - a. Riser Cables: Level 1.

- b. Feeder Cables: Level 1.
- E. Accessories:
  - 1. Battery Backup: System shall be provided with battery backup that provides 24 hours of standby power plus an additional 4 hours of full alarm notification activation.
  - 2. Location instruction sign: 6" x 8" Location & Instruction Sign – Silver.
  - 3. Elevator Landing Sign: 8" x 8" Emergency Communication Sign, Elevator Landings - Blue w/White Text.

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS FOR RESCUE ASSISTANCE

- A. Interfaces with Other Work:
  - 1. Coordinate installation of new products for two-way emergency communications systems for rescue assistance with elevator systems in elevator lobbies.
  - 2. Coordinate mounting location and conduit routing of the devices mounted adjacent to the elevator with the elevator installer. Do not route conduits in the elevator shaft.

### 3.02 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

### 3.03 FIELD QUALITY CONTROL OF TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS FOR RESCUE ASSISTANCE

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. Perform manufacturer's recommended tests and inspections.
  - 2. Perform field tests and inspections required by NFPA 72 and NFPA 1221.
- C. Nonconforming Work:
  - 1. Device will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports. Test reports shall be included in the O&M manuals.
- E. Manufacturer Services:
  - 1. Engage factory-authorized service representative or certified technician to support field tests and inspections.
  - 2. Train owner's personnel on the function and maintenance of the system. Provide a 1 hour training session at a time acceptable to the owner.

### 3.04 PROTECTION

- A. After installation, protect emergency communications systems devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

**END OF SECTION 28 48 00**

## SECTION 311000 - SITE CLEARING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

#### 1.02 RELATED REQUIREMENTS

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 015713 - Temporary Erosion and Sediment Control
- C. Section 017000 - Execution and Closeout Requirements
- D. Section 017419 - Construction Waste Management and Disposal
- E. Section 024100 - Demolition
- F. Section 312201 - Grading
- G. Section 312323 - Fill

#### 1.03 QUALITY ASSURANCE

- A. All work shall be performed in a safe and prudent manner.
- B. Clearing Firm: Company specializing in the type of work required.

### PART 2 PRODUCTS -- NOT USED

### PART 3 EXECUTION

#### 3.01 SITE CLEARING

- A. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

#### 3.02 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

#### 3.03 VEGETATION



- A. Scope: Clearing, grubbing, removing and disposal of all trees, shrubs, brush, and similar vegetation or other debris within the limits of the construction area(s), as shown on the plans or as directed by the Architect/Engineer.
- B. Do not remove or damage vegetation beyond the limits indicated on drawings.
- C. Vegetation Removal: Means all parts of the tree or brush, including the portion of the stumps and roots to a depth of 24 inches.
  - 1. Trees shall be removed without damage to nearby property.
  - 2. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.
- D. Vegetation Disposal: Contractor shall dispose of the vegetation removed in one of the following manners:
  - 1. Local landfill.
  - 2. Approved location. Contractor shall provide copies of all agreements with property owners on whose property the materials and debris are to be placed.
  - 3. Chip, grind, crush, or shred vegetation on site. Equipment used must be adequately covered to prevent materials from being projected in the area. Any damages caused by projectiles from these operations shall be remedied at the contractor's expense.
    - a. Any material not used on site as part of this project shall be disposed in one of the manners noted above.
- E. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.
- F. Restoration: If vegetation outside removal limits is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

#### 3.04 DEBRIS

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 311000

## SECTION 312100 - WATERING

### PART 1 - GENERAL

#### 1.01 SUMMARY:

- A. This item shall consist of furnishing and applying water required in the compaction of backfill, embankments, subgrades, base courses and surface course, or for the control of dust for the safety and convenience of the public, for the reduction of the dust nuisance with adjacent property, or for other purpose as required by the Contract Documents, or as directed by the Architect/Engineer, in accordance with the requirements of these Specifications.

### PART 2 - MATERIALS

#### 2.01 WATER SOURCE:

- A. The Contractor is responsible for obtaining water required for compaction of backfill, embankments, subgrade and gravel courses. If the water is obtained from the City of Gillette, private wells, or Improvement and Service Districts shall require payment for the appropriate fees required by the source owner. The City of Gillette may provide construction water for development projects provided a permanent water service connection that is installed as part of the development project will be used to obtain construction water. A temporary meter pit and backflow device shall be provided, Plant Investment Fees shall be paid in full, and a temporary water service account shall be created for the project.

### PART 3 - EXECUTION

#### 3.01 WATER ADDED

- A. Deficiencies in moisture content of backfill or embankment materials, crushed base, or surfacing courses shall be corrected by the addition of water by approved water distribution equipment. Water for dust control, finishing operations, and seeding shall be applied by approved distributor equipment.
  - 1. Grading Operations: Prewetting does not guarantee that additional water will not be required. Water added to embankment material during grading operations shall be distributed in a manner that will avoid ponding or overwetting materials for the full width of each layer of material placed.
  - 2. Crushed Base: Water added to crushed base shall be applied to the material immediately prior to mixing and placing the material.
  - 3. Finishing Operation: Water added during finishing operations shall be uniformly applied in a fine spray across the full width of the course by means of controllable pressures and spray bars or nozzles.
  - 4. Seeding: Water added to seeded areas shall be applied in a spray that will not wash or erode the seeded area.
  - 5. Dust Control: Water ordered for dust control measures for the protection and safety of traffic, for abatement of air pollution, or for other purposes, shall be applied in a manner that will best accomplish the elimination of dust.
  - 6. Mixing: Mixing is required when water is added into soil to bring the moisture content closer to optimum.

END OF SECTION 312100

## SECTION 312110 - DEWATERING

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered by this Section of the Specifications includes the furnishing of all labor, equipment and incidentals necessary for the dewatering of the project site, including trenches for water, sanitary sewer, and storm drain lines during construction.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312316.13 - Trenching
- C. Section 330500 - Manholes
- D. Section 331100 - Water Main
- E. Section 331110 - Water Valves and Valve Boxes
- F. Section 331120 - Fire Hydrants
- G. Section 331150 - Water Service
- H. Section 331200 - Corrosion Protection of Plastic Pipe Systems
- I. Section 333100 - Sanitary Sewer Piping
- J. Section 334200 - Storm Sewer Piping
- K. Section 334210 - Culverts
- L. Section 334250 - Storm Sewer Inlets

### PART 2 - MATERIALS

### PART 3 - EXECUTION

#### 3.01 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall furnish all labor, equipment, and incidentals necessary to dewater the project site during construction. All excavation shall be kept free of water during all construction and the placement of materials. No groundwater or storm water shall be allowed to enter or flow through the water or sanitary sewer lines installed in the project. Groundwater may be discharged into the existing storm drain if approved by the appropriate regulating agency and the Owner. The Contractor shall by pumping, dewatering wells, berming, coffer damming, sheet piling, or by other methods or combinations thereof, keep the construction area free from water.

- B. If the Contractor over excavates and places a clean rock in the bottom of the trench for dewatering, a barrier must be placed between this rock and the pipe bedding to prevent the migration of fine soil particles out of the bedding. This barrier shall be a geotextile fabric or polyethylene or polyurethane membrane of sufficient strength to resist damage when placed in this location and be of a material that does not deteriorate over time. The material and method of installation shall be approved by the Architect/Engineer.

### 3.02 FIELD QUALITY CONTROL

- A. It shall be the Contractor's responsibility to comply with all requirements and regulations of all federal, state, or local agencies that govern the handling of groundwater or stormwater, or other aspects of the work at the construction site or affected areas.
- B. Upon completion of the project tasks requiring the dewatering measures specified herein, the Contractor shall remove all such structures and restore all areas so disturbed to their original conditions and grade and in accordance with these Specifications. No berms, excavations for dewatering, or similar features shall be allowed to remain at the completion of the restoration. All restoration shall be approved by the Architect/Engineer.

### 3.03 PROTECTION

- A. At all times the Contractor shall provide sufficient protection to ensure the safety to personnel, equipment and materials, and the public for activities relating to dewatering. The protection of all equipment, materials, structures, or incidentals for this project are the responsibility of the Contractor. Any such equipment, materials, structures, or incidentals so placed or installed by the Contractor that are lost, damaged, or destroyed during construction shall be replaced by the Contractor at no additional cost to the Owner.

### 3.04 DISPOSAL

- A. The Contractor shall not allow water resulting from dewatering activities to be discharged or disposed of in such a manner as to flood existing landscaped areas, graveled areas or structures, cause erosion problems, or violate Wyoming Department of Environmental Quality Water Quality Regulations.

### 3.05 EXISTING STRUCTURES

- A. The Contractor's dewatering program shall be conducted in such a manner as to avoid damage to existing structures. The Contractor shall be responsible for repairing all structures damaged as a result of the dewatering. No extra payment shall be made to the Contractor for repairing any structures damaged by dewatering.

END OF SECTION 312110

## **Taylor Lee**

Plan One Architects  
255 W Yellowstone Ave.  
Suite 4  
Cody, WY 82414

# **REVISED SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT**



## **CAMPBELL COUNTY HIGH SCHOOL GILLETTE, WYOMING**



1300 E US Highway 14-16  
Gillette, WY 82716

**25054-LX**

**DATE ISSUED: NOVEMBER 17, 2025**

CIVIL | GEOTECHNICAL | ENVIRONMENTAL | MATERIALS TESTING | SURVEYING | DRILLING

November 17, 2025

25054-LX

**PDF REPORT EMAILED: [TLEE@PLANONE.COM](mailto:TLEE@PLANONE.COM)**

**CC: [DEIDE@PLANONE.COM](mailto:DEIDE@PLANONE.COM)**

**THIS CONSTITUTES THE ORIGINAL**

Mr. Taylor Lee  
Plan One Architects  
255 W. Yellowstone Ave., Suite 4  
Cody, WY 82414

RE: REVISED SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT  
CAMPBELL COUNTY HIGH SCHOOL  
GILLETTE, CAMPBELL COUNTY, WYOMING

Dear Mr. Lee:

This letter transmits our Revised Subsurface Exploration and Geotechnical Engineering report for the above-referenced project. The work described in this report has been completed in accordance with our Amendment Number 1 Service Agreement dated October 22, 2025, and supersedes the Subsurface Exploration and Geotechnical Engineering report dated October 10, 2025.

It has been a pleasure participating in this project. Additional services we could provide include:

- environmental assessment
- civil engineering
- plan and specification review
- surveying
- construction materials testing
- observation of excavations and earthwork

If you have any questions or comments, please contact our Gillette office at (307) 682-5000.

Sincerely,

INBERG-MILLER ENGINEERS



Kevin Stanek, P.E.  
Geotechnical Engineer



REVIEWED BY



Rami Ksaibati, P.E.  
Geotechnical Department Director

KCS:RAK:bb \P:\25054-LX PLAN ONE Campbell County High School\Geotech\Phase 2\25054-LX PLAN ONE ARCHITECTS Revised Subsurface Exploration Services Subsurface Report.docx

## TABLE OF CONTENTS

|            |                                                               |           |
|------------|---------------------------------------------------------------|-----------|
| <b>1.0</b> | <b>INTRODUCTION .....</b>                                     | <b>1</b>  |
| 1.1        | EXECUTIVE SUMMARY .....                                       | 1         |
| 1.2        | PURPOSE AND SCOPE OF SERVICE .....                            | 4         |
| <b>2.0</b> | <b>CONDITIONS .....</b>                                       | <b>4</b>  |
| 2.1        | SITE DESCRIPTION .....                                        | 4         |
| 2.2        | PROJECT CONDITIONS .....                                      | 4         |
| 2.3        | SOIL/ROCK CONDITIONS .....                                    | 5         |
| 2.4        | GROUNDWATER CONDITIONS .....                                  | 8         |
| <b>3.0</b> | <b>RECOMMENDATIONS .....</b>                                  | <b>9</b>  |
| 3.1        | SITE PREPARATION AND EARTHWORK .....                          | 9         |
| 3.2        | GROUND IMPROVEMENTS .....                                     | 11        |
| 3.3        | EAP ALTERNATE: SHALLOW FOUNDATIONS/INTERIOR FLOOR SLABS ..... | 11        |
| 3.4        | SHALLOW FOUNDATIONS .....                                     | 13        |
| 3.5        | INTERIOR SLABS-ON-GRADE .....                                 | 14        |
| 3.6        | EXTERIOR SLABS-ON-GRADE AND ATHLETIC FIELD .....              | 15        |
| 3.7        | PAVEMENT .....                                                | 15        |
| 3.8        | RETAINING WALLS .....                                         | 17        |
| 3.9        | SITE DRAINAGE AND CLAY CAP .....                              | 18        |
| 3.10       | GENERAL .....                                                 | 20        |
| 3.11       | CONSTRUCTION .....                                            | 21        |
| <b>4.0</b> | <b>TECHNICAL DATA .....</b>                                   | <b>22</b> |
| <b>5.0</b> | <b>STANDARD REPORT INFORMATION .....</b>                      | <b>22</b> |
| <b>6.0</b> | <b>CLOSURE .....</b>                                          | <b>22</b> |

### APPENDICES

#### Appendix A - FIELD EXPLORATION

Sample and Data Collection Information  
 Site and Exploration Location Map  
 Test Borings

#### Appendix B - LABORATORY TESTING

Laboratory Testing Program  
 Laboratory Test Reports

#### Appendix C – TERMINOLOGY, CONVENTIONS AND REPORT INFORMATION

Glossary  
 General Notes  
 Classification of Soils for Engineering Purposes  
 Important Information about your Geotechnical Engineering Report

## 1.0 INTRODUCTION

### 1.1 EXECUTIVE SUMMARY

Based on information obtained from our subsurface exploration and laboratory testing of recovered samples, it is our opinion that the site is suitable for the construction of the proposed Campbell County High School. In general, our subsurface exploration encountered the following strata and conditions:

#### *New High School Structure (Borings B-1 through B-10)*

From the existing ground surface to depths ranging from approximately 0.5 feet to over 36.5 feet below ground surface (bgs), subsurface materials generally consist of clayey sand, silty sand, and sandy clay, underlain locally by sandy silt.

The clayey and silty sands exhibit variable densities ranging from loose to very dense and are characterized by low to high strength, low to moderate compressibility, and low to moderate permeability.

The sandy clay layers encountered to depths of about 30 feet bgs exhibit soft to hard consistency, low to moderate strength, and low to moderate compressibility.

The sandy silt layers, encountered intermittently to depths of approximately 25 feet bgs, display firm to hard consistency, low to moderate strength, and moderate moisture sensitivity.

Laboratory consolidation testing indicates generally low swell potential and modest compressibility ( $C_c$  values ranging from 0.113 to 0.189). Limited collapse potential was noted in select sandy layers.

Groundwater was encountered within all borings aside from B-9 at depths ranging from 11 feet to 18 feet bgs.

#### *New Athletic Facilities (Borings B-11 through B-14)*

Soils in this area consist primarily of clayey sand/silty sand extending from near the surface to depths exceeding 31 feet bgs, underlain locally by sandy silt to depths of about 18 feet.

The clayey, silty sand soils range from loose to very dense and exhibit low to moderate compressibility and low to moderate permeability.

The sandy silt is generally soft to hard with moderate frost susceptibility and moisture sensitivity.

Consolidation testing indicates minimal collapse (up to -0.86% volumetric change) and compression index values up to 0.183, consistent with moderate compressibility.

Groundwater was encountered within borings B-11, B-13, and B-14 at depths ranging from 11 feet to 17 feet bgs.



*New Pavement Areas (Borings B-15 through B-21)*

Subsurface materials encountered in the proposed pavement areas, which are located throughout the subject site, consist of clayey sand/silty sand and sandy clay.

The sandy soils range from very loose to very dense, exhibiting low to moderate strength and compressibility, and low to moderate permeability.

The underlying sandy clay is soft to very stiff with low strength, low to moderate compressibility, and moderate frost susceptibility.

Groundwater was not encountered within the borings at the time of exploration.

*MCER Option 2C Additional Exploratory Borings (B-22 through B-24)*

Borings B-22 through B-24 were advanced to depths of 21.5 feet below ground surface (bgs). Subsurface materials generally consist of a thin surface layer of topsoil, underlain by sandy clay and sandy silt, which are in turn underlain by silty sand at greater depths.

The sandy clay and sandy silt occur at variable depths, generally between about 0.5 and 9 feet bgs. These soils exhibit soft to hard consistency, low to moderate strength, moderate compressibility, and low to moderate permeability. The materials are moderately moisture-sensitive and frost-susceptible, with low expansion/contraction potential and low to moderate collapse potential.

The underlying silty sand was encountered at depths ranging from approximately 2 feet to more than 21.5 feet bgs. This stratum exhibits medium dense to very dense consistency, moderate to high strength, low compressibility, and moderate to high permeability. The silty sand is characterized by low moisture sensitivity, low frost susceptibility, and low expansion/contraction and collapse potential.

Laboratory consolidation testing indicates generally low to moderate collapse potential and modest compressibility ( $C_c$  values ranging from 0.115 to 0.230) within the sandy clay and silty sand layers.

Groundwater was not encountered within the borings at the time of drilling.

Specific geotechnical issues that were identified during the course of our subsurface exploration included the following:

1. The proposed Campbell County High School location will be built over existing Campbell County High School structures, potentially yielding buried utilities, construction debris, or reinforced concrete remains. Removal of such structures may disturb soils below the bearing elevation for new foundations.
2. The site soils exhibit considerable variability in density and consistency, with soft zones of sandy clay and sandy silt that may result in differential settlement if not properly improved. Consolidation-swell test results indicate that on-site soils exhibit a low to moderate potential for collapse when inundated with water at 1,000 psf vertical loading.

3. Silty and fine-grained soils show moderate to high frost susceptibility and low to moderate moisture sensitivity. Poor drainage or infiltration beneath pavements or shallow foundations may induce heave or settlement. Proper compaction and moisture conditioning will be necessary to minimize post-construction settlement.
4. Depending on final grades, groundwater conditions at the site may be seasonally relatively high, which may adversely affect foundation performance if not properly controlled. Elevated groundwater levels can lead to instability of excavations, softening of bearing soils, and, if high enough, potential buoyancy forces acting on foundations and seepage, particularly where structural elements extend below the static water table. To mitigate these risks, a well-designed and properly maintained dewatering system will be essential. The system should be capable of maintaining the groundwater level at least 2 feet below the bottom of all foundation excavations during construction. Continuous monitoring and adjustment of the dewatering system will likely be required as excavation progresses. In addition, the design should incorporate a sump and pump arrangement or other means of active water control to maintain the lowered groundwater level throughout foundation installation and post-construction.

In summary, key geotechnical recommendations that apply to this project include:

1. The proposed new school and athletic facilities can be supported on conventional shallow foundations. To mitigate the risk of expansive and/or collapsible soils and to reduce the potential for total and differential settlement, we recommend that shallow spread and continuous footers be supported on ground improvements consisting of overexcavation of site soils and replacement with Structural Fill. The native site soils below bearing elevations of the proposed foundations should be overexcavated at least 24 inches and properly backfilled with Structural Fill according to Sections 3.1 and 3.2.
2. Alternatively, site subgrade soils can be improved with the use of Engineered Aggregate Piers (EAP) to support conventional shallow foundations and interior floor slabs. The use of EAP will significantly increase the allowable bearing capacity, reduce the potential for total and differential settlement, and allow for otherwise compressible soils to remain in place.
3. Removal of all existing structures and construction debris should be completed before any EAPs are installed or Structural Fill is placed. Obstructions to EAPs or drilled piers may cause damage to equipment or a false bearing stratum for support of the structure. As the densities of the materials increase with depth, drilling for EAPs may become difficult and should be considered.
4. Pavement sections should bear on properly compacted subgrade soils or Structural Fill. Areas of loose or soft soil should be overexcavated and replaced according to Section 3.7. Due to the anticipated flat topography of the athletic field and track, it is recommended to place an interior drain system to collect surface water from the athletic playing surfaces. This system should be installed along the interior edge of the track and as otherwise recommended by the track supplier/installer.

A proof roll is recommended for the entire roadway, parking, athletic field, and track before any pavement, road base, or track surfacing is placed. The proof-roll is intended to identify relatively soft or yielding areas so that they can be improved and brought to a consistent level of subgrade performance across the project area.

5. Proper site drainage should be achieved and maintained throughout the life of the structures, pavements, and track to prevent surface water infiltration into subgrade soils beneath/around the foundations, pavements, and track. Grades may need to be modified to ensure that positive drainage is achieved. Satisfactory performance of the foundations, pavements, and track depends on stable moisture conditions, positive drainage, and proper separation of moisture.

## **1.2 PURPOSE AND SCOPE OF SERVICE**

Inberg-Miller Engineers was requested by Plan One Architects to perform a subsurface exploration and prepare this geotechnical engineering report for the purpose of providing recommendations for the design of Campbell County High School. Our specific scope of service is described by our July 30, 2025, Proposal and subsequent Amendments, as applicable.

## **2.0 CONDITIONS**

### **2.1 SITE DESCRIPTION**

The project site is located at 1000 Camel Dr, Gillette, WY, bounded by E 12<sup>th</sup> St to the north, Camel Dr to the east, Providence Ln to the west, and Interstate 90 to the south. The overall ground surface of the site slopes gently towards the northwest. The site includes the current high school and athletic facilities, along with bordering undeveloped property and residential structures. The MCER Option 2C location is directly south of the existing school structure, between the tennis courts on the west and the soccer field to the east. The ground surface is covered by asphalt, concrete, native grasses and weeds, and current structures.

### **2.2 PROJECT CONDITIONS**

Project conditions were either provided by Taylor Lee with Plan One Architects, John Shaffer with Martin-Martin Wyoming, Craig Shavlik of KL&A, or were assumed based on our experience with similar types of construction. These conditions are tabulated below and form the basis for recommendations provided within this report. Please contact Inberg-Miller Engineers if conditions differ from those stated.

We understand the project will consist of the construction of a new high school, approximately 170,000 square feet in size, either on the site of the existing CCHS football field, within the MCER Option 2C location, or a combination of both. As part of the project, a new football field, track, and grandstand will be constructed in the area currently occupied by the parking lot and landscaped space to the east of the existing football field. After the new school is completed, the existing building will be demolished and replaced with parking facilities. Additional parking and drive areas will be incorporated into the campus design.

At the time of this report, the plans did not indicate that a pool would be incorporated into the new school design. Loading considerations for the new athletic facility, grandstands, locker rooms, or concession stand are assumed in the table below.

|                                       |                             |
|---------------------------------------|-----------------------------|
| 1-Story Building Loads (32'x24' bays) | Per Martin-Martin Wyoming   |
| Interior columns                      | ≤ 40 kips                   |
| Exterior columns                      | ≤ 20 kips                   |
| 2-Story Building Load (32'x24' bays)  | Per Martin-Martin Wyoming   |
| Interior columns                      | ≤ 180 kips                  |
| Exterior columns                      | ≤ 120 kips                  |
| Gymnasium (CMU walls)                 | Per Martin-Martin Wyoming   |
| Height                                | 32 feet                     |
| Joint span                            | 110 feet, 7.1 kips / lft    |
| Athletic Facility Structures          | Assumed                     |
| Column load range                     | 30-60 kips                  |
| Wall load range                       | 3-5 kips per foot           |
| Maximum Cut                           | < 10 feet (per KL&A)        |
| Maximum Fill (feet)                   | < 10 feet (per KL&A)        |
| Pavement Loading – Heavy Duty Areas   | 100 ESALs per Day (Assumed) |
| Pavement Loading – Light Duty Areas   | 50 ESALs per Day (Assumed)  |
| Total Settlement Tolerance            | < 1 inch                    |
| Differential Settlement Tolerance     | < 0.5 inches per 50 feet    |

### 2.3 [SOIL/ROCK CONDITIONS](#)

A summary of soil or rock conditions that were encountered and recorded on the logs is provided below. For a more detailed description of conditions, refer to the test boring logs presented in Appendix A.

*New High School Structure (Borings B-1 through B-10)*

|                                 | <b>TOPSOIL</b>          | <b>Clayey SAND/Silty SAND</b>            | <b>Sandy CLAY</b>                    | <b>Sandy SILT</b>                  |
|---------------------------------|-------------------------|------------------------------------------|--------------------------------------|------------------------------------|
| USCS Classification             | -                       | SC/SM/SC-SM                              | CL                                   | ML                                 |
| Density/Consistency             | -                       | Loose to Very Dense                      | Soft to Hard                         | Firm to Hard                       |
| Boring Occurrence               | B-2 to B-7, B-9 to B-10 | B-1 to B-10                              | B-1, B-3, B-5, B-6 to B-7            | B-2, B-4, B-7, B-10                |
| Vertical Limits                 | 0' to 0.5'              | Variable; 0.5' to > 36.5', refer to logs | Variable; 0.5' to 30', refer to logs | Variable; 2' to 25', refer to logs |
| Strength                        | -                       | Low to High                              | Low to Moderate                      | Low to Moderate                    |
| Compressibility                 | -                       | Low to Moderate                          | Low to Moderate                      | Low to Moderate                    |
| Permeability                    | -                       | Low to Moderate                          | Low                                  | Low                                |
| Moisture Sensitivity            | -                       | Low to Moderate                          | Moderate                             | Moderate                           |
| Frost Susceptibility            | -                       | Low to High                              | Low to Moderate                      | Moderate to High                   |
| Expansion/Contraction Potential | -                       | Low                                      | Low to Moderate                      | Low to Moderate                    |
| Collapse Potential              | -                       | Low to Moderate                          | Low to Moderate                      | Low to Moderate                    |

*New Athletic Facilities (Borings B-11 through B-14)*

|                                 | <b>TOPSOIL</b>   | <b>Clayey SAND/Silty SAND</b>            | <b>Sandy SILT</b>                    |
|---------------------------------|------------------|------------------------------------------|--------------------------------------|
| USCS Classification             | -                | SC/SM/SC-SM                              | ML/MH                                |
| Density/Consistency             | -                | Loose to Very Dense                      | Soft to Hard                         |
| Boring Occurrence               | B-11, B-12, B-14 | B-11 to B-14                             | B-11, B-14                           |
| Vertical Limits                 | 0' to 0.5'       | Variable; 0.5' to > 31.4', refer to logs | Variable; 0.5' to 18', refer to logs |
| Strength                        | -                | Low to High                              | Low to Moderate                      |
| Compressibility                 | -                | Low to Moderate                          | Low to Moderate                      |
| Permeability                    | -                | Low to Moderate                          | Low                                  |
| Moisture Sensitivity            | -                | Low to Moderate                          | Moderate                             |
| Frost Susceptibility            | -                | Low to High                              | Moderate to High                     |
| Expansion/Contraction Potential | -                | Low                                      | Low to Moderate                      |
| Collapse Potential              | -                | Low to Moderate                          | Low to Moderate                      |

*New Pavement Areas (Borings B-15 through B-21)*

|                                 | <b>TOPSOIL</b>  | <b>Clayey SAND/Silty SAND</b>           | <b>Sandy CLAY</b>                       |
|---------------------------------|-----------------|-----------------------------------------|-----------------------------------------|
| USCS Classification             | -               | SC/SM/SC-SM                             | CL                                      |
| Density/Consistency             | -               | Very Loose to Very Dense                | Soft to Very Stiff                      |
| Boring Occurrence               | B-16, B-19      | B-16, B-17, B-18, B-19, B-21            | B-15, B-20                              |
| Vertical Limits                 | 0' to 0.5'-1.0' | Variable; 0.5' to > 6.5', refer to logs | Variable; 0.8' to > 6.5', refer to logs |
| Strength                        | -               | Low to Moderate                         | Low                                     |
| Compressibility                 | -               | Low to Moderate                         | Low to Moderate                         |
| Permeability                    | -               | Low to Moderate                         | Low                                     |
| Moisture Sensitivity            | -               | Low to Moderate                         | Low to Moderate                         |
| Frost Susceptibility            | -               | Low to High                             | Low to Moderate                         |
| Expansion/Contraction Potential | -               | Low                                     | Low to Moderate                         |
| Collapse Potential              | -               | Low to Moderate                         | Low to Moderate                         |

*MCER Option 2C Additional Exploratory Borings (B-22 through B-24)*

|                                 | <b>TOPSOIL</b>    | <b>Sandy CLAY/Sandy SILT</b>          | <b>Silty SAND</b>                       |
|---------------------------------|-------------------|---------------------------------------|-----------------------------------------|
| USCS Classification             | -                 | CL/ML                                 | SM                                      |
| Density/Consistency             | -                 | Soft to Hard                          | Medium Dense to Very Dense              |
| Boring Occurrence               | B-22 through B-24 | B-22 through B-24                     | B-22 through B-24                       |
| Vertical Limits                 | 0' to 0.5'        | Variable; 0.5' to 9.0', refer to logs | Variable; 2.0' to >21.5', refer to logs |
| Strength                        | -                 | Low to Moderate                       | Moderate to High                        |
| Compressibility                 | -                 | Moderate                              | Low                                     |
| Permeability                    | -                 | Low to Moderate                       | Moderate to High                        |
| Moisture Sensitivity            | -                 | Moderate                              | Low                                     |
| Frost Susceptibility            | -                 | Moderate                              | Low                                     |
| Expansion/Contraction Potential | -                 | Low                                   | Low                                     |
| Collapse Potential              | -                 | Moderate                              | Moderate                                |

**Summary of Consolidation / Swell Testing**

| <b>Soil Description</b> | <b>Boring #</b> | <b>Depth (ft)</b> | <b>Volumetric Swell (%)</b> | <b>Swell Pressure (psf)</b> | <b>Compression Index, Cc</b> |
|-------------------------|-----------------|-------------------|-----------------------------|-----------------------------|------------------------------|
| Gray SILT               | B-2             | 5'                | 0.18% (swell)               | 1,200 psf                   | 0.189                        |
| Gray CLAY               | B-7             | 10'               | 0.13% (swell)               | 1,100 psf                   | 0.141                        |
| Light Brown SAND        | B-9             | 20'               | -0.20% (collapse)           | N/A                         | 0.113                        |
| Gray SILT               | B-11            | 7.5'              | -0.86% (collapse)           | N/A                         | 0.183                        |
| Gray Sandy CLAY         | B-22            | 7.5'              | -1.58% (collapse)           | --                          | 0.115                        |
| Gray CLAY               | B-23            | 7.5'              | -1.62% (collapse)           | --                          | 0.230                        |

**2.4 GROUNDWATER CONDITIONS**

A summary of groundwater observations and measurements that were made during the subsurface exploration are provided below. Additional details are documented on the test boring logs presented in Appendix A.

| <b>Boring No.</b> | <b>Depth to Groundwater bgs</b> | <b>Date</b> | <b>Time</b>    |
|-------------------|---------------------------------|-------------|----------------|
| B1                | 17.2 feet                       | 8/28/2025   | After Drilling |
| B2                | 17.0 feet                       | 8/26/2025   | After Drilling |
| B3                | 17.3 feet                       | 8/29/2025   | After Drilling |
| B4                | 17.3 feet                       | 8/26/2025   | After Drilling |
| B5                | 11.0 feet                       | 8/28/2025   | After Drilling |
| B6                | 15.5 feet                       | 8/25/2025   | After Drilling |
| B7                | 18.0 feet                       | 8/26/2025   | After Drilling |
| B8                | 11.0 feet                       | 8/28/2025   | After Drilling |
| B10               | 11.5 feet                       | 8/27/2025   | After Drilling |
| B11               | 17.0 feet                       | 8/28/2025   | After Drilling |
| B13               | 17.0 feet                       | 8/29/2025   | After Drilling |
| B14               | 11.0 feet                       | 8/29/2025   | After Drilling |

At the time of our subsurface exploration, no groundwater was observed in the test borings B9, B12, B15 through B24 before they were backfilled. Groundwater may be present at the site within the range of exploration depth, but may not have been observable for numerous reasons, such as low soil permeability or impeded drainage.

Groundwater conditions could change with seasonal or long-term changes in climatic conditions and post-construction changes in irrigation and surface water runoff. Generally, developed sites have a significantly greater volume of water available to percolate into the ground due to irrigation and stormwater runoff from hard surfaces. Localized, perched

groundwater tables may develop above clay layers or bedrock, or within the foundation backfill zone.

### 3.0 **RECOMMENDATIONS**

#### 3.1 **SITE PREPARATION AND EARTHWORK**

##### **Site Preparation**

|                          |                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------|
| Stripping Depth (inches) | 6 to 12 inches or until all organics, pavement, and previous structures are removed                     |
| Proof-Rolling            | Pavement Subgrade, Pavement Base, Slab Subgrade, Athletic Field Subgrade, Track Subgrade, and fill base |

1. After stripping and excavating to the design subgrade elevation, native site soil should be scarified to a depth of at least 8.0 inches, moisture conditioned, and recompact according to the recommendations outlined within the tables below.
2. Proof-rolling should be performed with a wheeled vehicle exerting relatively high soil-contact pressure for the subject area, considering space constraints and access. Examples of suitable equipment include loaded dump trucks or end-loaders carrying a full bucket of soil.
3. Subgrades to receive structures, pavement, or fill material should respond uniformly to loading, and be free of organic materials, protruding rocks, debris, old fill, buried structures, or otherwise soft and compressible soil or material.
4. Weak or yielding subgrades should be repaired as recommended by the geotechnical engineer. Repairs may include soil excavation and replacement, possibly including proper geotextile fabric, depending on circumstances.

##### **Fill and Backfill Materials**

| Classification   | Suitable Materials          | Source   |
|------------------|-----------------------------|----------|
| Structural Fill  | WYDOT Grading W, Envelope A | Imported |
| Slab Base        | WYDOT Grading W             | Imported |
| Slab Subbase     | Envelope A                  | Imported |
| Pavement Base    | WYDOT Grading W             | Imported |
| Pavement Subbase | USCS-SW, SP, GW, GP, SC, GC | On-site  |
| Site Fill        | Native Site Soils           | On-site  |



- Specifications for recommended graded materials are as follows:

| Envelope A                 |               | WYDOT Grading W           |               |
|----------------------------|---------------|---------------------------|---------------|
| Sieve                      | Percent Finer | Sieve                     | Percent Finer |
| 1½"                        | 100           | 1½"                       | 100           |
| #4                         | 50-100        | 1"                        | 90-100        |
| #8                         | 30-90         | ½"                        | 60-85         |
| #30                        | 15-75         | #4                        | 45-65         |
| #50                        | 10-60         | #8                        | 33-53         |
| #200                       | 0-20          | #200                      | 3-12          |
| Liquid Limit < 40, PI < 15 |               | Liquid Limit < 25, PI < 3 |               |

### Compaction

|                                                       |                                                                                          |
|-------------------------------------------------------|------------------------------------------------------------------------------------------|
| Below Foundations                                     | 6-inch layers, 93% ASTM D1557                                                            |
| Below Pavements, Slabs, Athletic Field/Track Surfaces | 8-inch layers, 93% ASTM D1557                                                            |
| Trenches                                              | 8-inch layers, 93% ASTM D1557                                                            |
| Clay Cap                                              | 8-inch layers, 90% ASTM D1557                                                            |
| Site Fill/Landscaped Areas                            | 12-inch layers, 90% ASTM D1557                                                           |
| Compaction Moisture Content                           | Moisture conditioned between -2 and +2 percentage points of the optimum moisture content |

- The contractor's equipment and procedures should produce a horizontal, uniformly mixed, and compacted lift. In-place density and water content of each lift of fill materials should be tested and approved, or as otherwise recommended by the geotechnical engineer.
- If construction takes place during cold weather, care should be taken to prevent construction on frozen soils. In addition, fill materials should not contain snow and/or ice and should not be placed in a frozen condition.

### Temporary and Permanent Slopes

|                      |              |
|----------------------|--------------|
| Temporary Fill Slope | 2.5 H: 1.0 V |
| Temporary Cut Slope  | 2.0 H: 1.0 V |
| Permanent Fill Slope | 3.0 H: 1.0 V |
| Permanent Cut Slope  | 4.0 H: 1.0 V |

- Slopes, whether temporary (during construction) or permanent, will require careful management of surface water through design and maintenance to protect slopes from saturation.
- Some slope conditions, especially when supporting structures or pavement loads, may have marginal safety factors against stability. Permanent and temporary slopes should be evaluated for stability when circumstances are better defined. Recommended values are provided for preliminary planning purposes only.
- Slopes should be protected from erosion with vegetation, matting, or other measures.

### 3.2 [GROUND IMPROVEMENTS](#)

#### **Foundations**

|                                |                                                                                                                                                                                                                                    |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Location                       | Below Bearing Elevation of Shallow Foundations                                                                                                                                                                                     |
| Overexcavation Depth and Width | 24 inches below bearing elevation, 24 inches outside footing perimeter                                                                                                                                                             |
| Backfill                       | Structural Fill                                                                                                                                                                                                                    |
| Clay Cap                       | Suitable clay material should be used to form a 16-inch-thick clay cap (per Section 3.9) that prevents surface runoff from percolating downward and collecting within the granular structural fill material below the foundations. |
| Compaction                     | 6-inch layers, 93% ASTM D1557                                                                                                                                                                                                      |
| Geosynthetic Reinforcement     | Not Anticipated                                                                                                                                                                                                                    |

#### **Interior Floor Slabs**

|                                |                               |
|--------------------------------|-------------------------------|
| Location                       | Below Interior Slab Base      |
| Overexcavation Depth and Width | 12 inches below Slab Base     |
| Backfill                       | Structural Fill               |
| Compaction                     | 6-inch layers, 93% ASTM D1557 |
| Geosynthetic Reinforcement     | Not Anticipated               |

#### **Pavement**

|                                |                                                                |
|--------------------------------|----------------------------------------------------------------|
| Location                       | Below Pavement Base                                            |
| Overexcavation Depth and Width | 12 inches below pavement base, 12 inches outside pavement edge |
| Backfill                       | Native Site Soils                                              |
| Compaction                     | 6-inch layers, 93% ASTM D1557                                  |
| Geosynthetic Reinforcement     | Not Anticipated                                                |

#### **Artificial Athletic Field**

|                            |                                                              |
|----------------------------|--------------------------------------------------------------|
| <b>Location</b>            | Below the artificial turf aggregate drainage layer           |
| Overexcavation Depth       | 12 inches below the artificial turf aggregate drainage layer |
| Backfill                   | Structural Fill                                              |
| Compaction                 | 6-inch layers, 93% ASTM D1557                                |
| Geosynthetic Reinforcement | Not Anticipated                                              |

Geosynthetic reinforcement may be necessary if soft or yielding conditions develop during construction. The geotechnical engineer should be notified if these conditions develop to further refine recommendations for geosynthetic use.

### 3.3 [EAP ALTERNATE: SHALLOW FOUNDATIONS/INTERIOR FLOOR SLABS](#)

Alternatively, the proposed structure can be supported on conventional continuous and spread footings bearing on a subgrade improved with the use of Engineered Aggregate Piers (EAP). In addition, the use of EAP under floor slabs is also recommended.

Considering the depth of overexcavation and replacement of the soft to loose layers of sandy clay and silty sand, the time required for soil replacement, and requirements for settlement control, we believe that EAP will provide a cost-effective solution. The installation of EAP groups will substantially increase the allowable bearing capacity and reduce the potential for settlement of spread footing foundations and slabs on-grade. Typically constructed in pre-excavated cavities drilled to specified depths, the piers should be installed with high-energy, vertical ramming equipment. A pattern of piers should be installed below each isolated footing and at intervals along continuous strip footings, as well as beneath floor slabs. This method involves drilling pier shafts to predetermined depths and backfilling each drill cavity immediately after drilling with crushed aggregate that is heavily rammed with high-energy vertical force. Relatively thin lifts (approximately 12 inches) of aggregate material should be placed in order to maximize lateral stresses imposed into the undisturbed soils surrounding the pier element, which creates a reinforced layer within the compressible soil zone that is much stiffer than the untreated soil. The pier elements typically range from 18 to 36 inches in diameter.

Typically, EAP systems are provided by a specialty contractor on a design-build basis; therefore, we do not provide specific design input parameters for the pier design. We recommend that the structural engineer consult with the design-build contractor during the design phase to select appropriate footing design parameters. We recommend that the EAP system be contracted for design and construction on a performance basis using the following criteria:

- The EAP bearing capacity should be designed by the specialty contractor in coordination with the geotechnical and structural engineers to meet project-specific requirements.
- The EAP system shall provide less than 1 inch of total settlement and differential settlement of less than ½ inch in 50 feet beneath foundations. The EAP system design settlement parameters should include any movement contributions from the soil zone beneath the bottom of the piers.
- For lateral sliding of spread footings supported on EAP, we recommend a sliding coefficient of 0.4 be used.
- The floor slab should be separated from bearing walls and columns with expansion joints in accordance with ACI recommended practices to allow for unrestrained vertical movements. The EAP design shall provide a minimum of 200 pounds per cubic inch overall subgrade reaction for floor slab support and provide less than 1-inch settlement beneath slabs.

Installation of the EAP system should be observed by the geotechnical engineer. Observations should, at a minimum, include the following:

- Monitor installation procedures relative to project specifications and confirm that subsurface conditions across the installation area, as revealed by the pier drilling, are in general agreement with the project geotechnical explorations.

- A Daily EAP Progress Report shall be completed during each day of installation, and, at a minimum, consist of the following:
  - Date of installation and summary of installation equipment and installation procedures
  - Pier location, length, and diameter
  - Final elevations of the pier top and bottom
  - Documentation of any unusual subsurface conditions encountered
  - Soil and groundwater observations, if any
  - The results of any field Quality Control testing done

For frost protection and to provide containment for the bearing soils, exterior footings should extend to a minimum depth of 42 inches below the finished exterior grade. Interior footings within heated areas of the building should extend to a minimum depth of 12 inches below the floor subgrade. Installation of the engineered aggregate piers should be observed by the geotechnical engineer.

### 3.4 SHALLOW FOUNDATIONS

|                                         |                                                                                                               |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Suitable Bearing Strata                 | 24 inches of Structural Fill according to Sections 3.1 and 3.2<br><b>OR</b><br>EAPs, according to Section 3.3 |
| Allowable Net Bearing Pressure          | 2,000 psf<br><b>OR</b><br>Per EAP Contractor (5,000 psf minimum)                                              |
| Pressure Increase for Transient Loading | Increase of 1/3                                                                                               |
| Clay Cap                                | Per Section 3.9                                                                                               |
| Minimum Footing Width                   |                                                                                                               |
| Continuous                              | 18 inches                                                                                                     |
| Isolated Pad                            | 36 inches                                                                                                     |
| Total Settlement                        | 1 inch                                                                                                        |
| Differential Settlement                 | 0.5 inches per 50 feet                                                                                        |
| Potential Heave Conditions              | Low to Moderate                                                                                               |
| Potential Collapse Conditions           | Low to Moderate                                                                                               |
| Embedment                               |                                                                                                               |
| Exterior Footings                       | 42 inches (City of Gillette, WY)                                                                              |
| Interior Footings                       | 12 inches                                                                                                     |

1. As applicable, all loose soil and rock fragments should be removed from the foundation subgrade, which may require some hand work. If the footing subgrades require leveling (less than 6-inches), portland cement concrete should be used as the leveling course. Deeper fills beneath the foundations can be completed using structural fill or lean concrete, or all footings can be extended to the excavation depth and be placed on well-prepared bedrock.

2. Steel should be placed and the foundation poured the same day of excavation. The bearing surface should be excavated with a slight slope to create an internal sump for runoff water collection and removal. If water in excess of one (1) inch accumulates at the bottom of the excavation, it should be pumped out prior to concrete placement. Under no circumstances should water be allowed to adversely affect the quality of the bearing surface.
3. Footing subgrades should be observed by the Geotechnical Engineer prior to concrete placement to identify suitable bearing materials and to observe whether the foundation soils have been properly prepared prior to foundation construction. All loose or soft soils in the footing excavation should be removed from the foundation excavation prior to concrete placement. Footings should not be placed on either uncompacted on-site soil or uncompacted fill.

### 3.5 INTERIOR SLABS-ON-GRADE

|                                          |                                                                                                                 |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Suitable Subgrade Strata                 | 12 inches of Structural Fill according to Sections 3.1 and 3.2<br><b>OR</b><br>Engineered Aggregate Piers (EAP) |
| Base                                     | A minimum of 6" of WYDOT Grading W Base according to Section 3.1                                                |
| Maximum Allowable Bearing Pressure (psf) | 200 psf                                                                                                         |
| Subgrade Modulus (pci)                   | 200 pci                                                                                                         |
| Moisture Vapor Control                   | Recommended for finished floors                                                                                 |
| Potential Heave Conditions               | Low to Moderate                                                                                                 |
| Potential Collapse Conditions            | Low to Moderate – positive surface drainage away from the proposed structure is important to achieve            |

1. The aggregate base course will not provide an effective capillary break for moisture rise to the slab.
2. The floor slabs should have an adequate number of joints to reduce cracking resulting from differential movement, shrinkage, and curing stresses. The floor slab should be considered "floating" and may move differentially with respect to the building and foundation supported equipment. Consequently, isolation joints should be placed between the floor, building walls, and foundation supported equipment.
3. Because potential heave or collapse conditions have been identified, the floor slab should be supported independently from the foundation system. The slab should be isolated from perimeter walls and allowed to move vertically and separately from the building frame. Partitions and interior walls should not bear directly on the floor but should be constructed to allow vertical movement of the floor. A minimum 2-inch void should be provided above or below non-bearing partition walls constructed above the floating slab. Special framing details are required for door jams and frames within partition walls to accommodate potential movement.

4. If moisture vapor control is recommended, synthetic vapor barriers should comply with ASTM E1745, Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs and have a performance characteristic of 0.006 Water Vapor Transmission Rate (WVTR) or lower as tested by ASTM E96. Vapor barriers should be installed per the manufacturer's recommendations.
5. If concrete is placed directly on a vapor barrier, special care is required in concrete mix design for shrink resistance as well as in placement practices to avoid the effects of differential drying caused by the barrier and environmental conditions. If granular soil is placed between the concrete and vapor barrier, care is required to prevent water from entering the soil and becoming trapped prior to concrete placement.

### 3.6 EXTERIOR SLABS-ON-GRADE AND ATHLETIC FIELD

Exterior slabs and the athletic field are subject to frost heave due to the formation of ice lenses in underlying frost susceptible soils. The potential for frost heave may not be acceptable at doorways or other critical areas adjacent to the building or areas of the field that will be exposed to freezing weather. One approach to provide partial frost protection would be to place and compact a minimum of 24 inches of non-frost susceptible aggregate base course beneath the slabs or 12 inches beneath the field. Alternatively, if partial frost protection is unacceptable, over-excavation and aggregate base course replacement must be accomplished to the full frost depth of 42 inches. The aggregate base course should meet the requirements of WYDOT Grading W material. If the overexcavation and replacement method allows for surface water to saturate the base course, some frost heave may be expected.

### 3.7 PAVEMENT

Pavement section designs were performed in accordance with procedures given in the AASHTO Guide for Design of Pavement Structures, American Association of State Highway Transportation Officials, 1993. Design traffic volumes were assumed based on our experience and published values for similar facilities. A design soil California Bearing Ratio (CBR) value of 3.0% calculated from a Group Index (G.I.) value of 14 was utilized for the design of pavement sections.

#### **DESIGN PARAMETER INPUTS**

| Pavement Type                            | Flexible Pavement<br>(Asphalt) | Rigid Pavement<br>(Concrete) |
|------------------------------------------|--------------------------------|------------------------------|
| Reliability (%)                          | 90%                            | 95%                          |
| Initial Serviceability                   | 4.2                            | 4.5                          |
| Terminal Serviceability                  | 2.0                            | 2.0                          |
| Overall Standard Deviation (So)          | 0.45                           | 0.35                         |
| Effective Roadbed Resilient Modulus (Mr) | 4,100 psi                      | ----                         |
| Modulus of Subgrade Reaction (k)         | ----                           | 200 pci                      |
| Concrete Compressive Strength (f'c)      | ----                           | 4,000 psi                    |
| Desing Life                              | 20 years                       | 20 years                     |

|                                | Heavy Duty                  | Light Duty                      |
|--------------------------------|-----------------------------|---------------------------------|
| Description                    | Bus, Truck, and Drive Areas | Passenger Vehicle Parking Areas |
| Design ESAL per Day            | 100 ESALs per Day           | 50 ESALs per Day                |
| Minimum Structural Number (SN) | 3.95                        | 3.52                            |

**FLEXIBLE PAVEMENT (ASPHALT) SECTION**

| Pavement Type                 | Heavy Duty | Light Duty |
|-------------------------------|------------|------------|
| Hot Mix Asphalt               | 6 in       | 6 in       |
| Pavement Base                 | 12 in      | 8 in       |
| Reconditioned Native Subgrade | 12 in      | 12 in      |

**RIGID PAVEMENT (CONCRETE) SECTION**

| Pavement Type                 | Heavy Duty | Light Duty |
|-------------------------------|------------|------------|
| Portland Cement Concrete      | 7.5 in     | 6 in       |
| Pavement Base                 | 6 in       | 6 in       |
| Reconditioned Native Subgrade | 12 in      | 12 in      |

**ATHLETIC TRACK SECTION**

| Pavement Type                 | Athletic Track                                |
|-------------------------------|-----------------------------------------------|
| Track Surfacing               | Section Design According to the Installer     |
| Asphalt or Concrete           | 3.0 inches (Asphalt)<br>4.0 inches (Concrete) |
| WYDOT Grading W               | 6.0 inches                                    |
| Reconditioned Native Subgrade | 12 inches                                     |

1. Asphalt Pavement materials should meet applicable requirements of the City of Gillette Standard Construction Specifications, 2020. The asphalt concrete should be placed in maximum 3-inch-thick compacted lifts.
2. Tack coats conforming to Section 02551 are recommended between lifts. Maximum size aggregate of 1/2 inch should be used for the upper lift. Either 1/2-inch or 3/4-inch maximum size aggregate may be used for the lower lifts.
3. Reconditioned pavement and track subgrades should be scarified to a minimum depth of 12 inches, moisture conditioned and compacted as described in Section 3.1. Prior to placing any aggregate base or pavement, the subgrade should be proof-rolled and any soft spots improved.
4. Portland cement concrete materials should meet the requirements of the City of Gillette Standard Construction Specifications, 2020, 4,000 psi Class B Concrete. Five (5) to eight (8) percent air entrainment is recommended for concrete exposed to weather and for concrete workability. Steel reinforcement is not required within the pavement; however, dowels should be provided across construction joints to transfer loads and resist pavement displacement. Dowels should have sufficient diameter and spacing to transfer vertical loads, while allowing horizontal movement due to expansion and contraction of the concrete pavement.

5. For unreinforced concrete pavement, joints should be placed so that slab panels are as square as possible. Contraction joints should have a maximum width of  $\frac{1}{4}$  inch and be cut at least  $\frac{1}{4}$  of the depth of the concrete. Contraction joints can be either tooled or saw cut. Expansion joints should be placed at the ends of the valley pans and between the pavement and curbs or walls. Expansion joints should have a minimum width of  $\frac{1}{2}$  inch. All contraction and expansion joints should be filled with a field-molded sealant to prevent the infiltration of water into the underlying soils.
6. This report is not intended to provide sufficient information for detailing joints for complex pavements. Joint requirements are dependent on concrete materials and the geometry of the pavement. Joint details can be critical to the performance of a project and should be designed by knowledgeable professionals.
7. Provisions should be made to periodically observe the conditions of the pavements and perform maintenance on cracks and joints, as required. Observed drainage problems should be promptly remedied. A primary focus of the pavement maintenance plan is to prevent subgrade soils from becoming wet.

### 3.8 RETAINING WALLS

| Condition                                                                                                                                | Native Sand Soils | Grading A Fill |
|------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------|
| Active Lateral Soil Pressure – for structures that can deflect without restraint by other structures (equivalent fluid unit weight, pcf) | 33                | 40             |
| At-Rest Lateral Soil Pressure - for structures that have significant restraint against deflection (equivalent fluid unit weight, pcf)    | 70                | 60             |
| Passive Lateral Soil Pressure – resistance of soil abutting a structure (equivalent fluid unit weight, pcf)                              | 443               | 460            |
| Coefficient of Friction Between Foundation and Underlying Soil                                                                           | 0.4               | 0.5            |
| Soil Density, Wet Soil (pcf)                                                                                                             | 120               | 135            |

1. These parameters assume the retaining structure and soils are above the water table. The parameters do not include a factor of safety. A minimum factor of safety of 2.0 is recommended for horizontal loading.
2. Where possible, foundations should be backfilled and compacted evenly on all sides to prevent horizontal movement. Basement/crawl space walls and retaining walls should be adequately braced prior to backfilling.
3. Surcharge loads on the uphill side of the wall due to ground slope, soil stockpiles, equipment, and structures may significantly increase lateral forces on the wall and need to be fully evaluated.
4. Drains should be installed behind retaining walls or other confined areas where surface precipitation and runoff water can collect. Drains should be designed to prevent the build-up of hydrostatic pressures behind the retaining structures due to trapped water.



### 3.9 SITE DRAINAGE AND CLAY CAP

Consistent with the International Building Code (IBC), the ground surface adjacent to the structure should be sloped a minimum of 5% away from foundations within 10 feet of the structure. If the slope adjacent to the structure is paved with asphalt or concrete, the slope can be reduced to 2%. Slope the ground surface beyond 10 feet of the structure at least 2% away to pavement, ditch, or other positive drainage system. Negative drainage and improper management of near-surface water by not providing an effective grading and drainage design, can result in moisture entering the structure subgrade soils. Sources of near surface water may include pressurized irrigation and water supply lines, rainwater, snowmelt, and roof drains. Downspouts and roof drains should discharge at least 5 feet away from the structure when the ground surface beneath such drains is not protected by exterior slabs or paving. Landscape irrigation within 10 feet of the structure perimeter should be minimized or eliminated where positive drainage away from the structure cannot be assured. Backfill against the footings and exterior walls and in utility trenches should be well compacted to reduce the potential for moisture infiltration.

If water is permitted to accumulate or pond next to the structure and penetrate the subgrade soils, larger soil movements may be experienced than those discussed in this report. These increased movements can result in undesirable differential settlements or heave and floor slab/wall cracking. The estimated settlement values described in this report are dependent on positive drainage throughout the life of the structure and cannot be relied upon if effective drainage is not maintained.

If water is permitted to accumulate or pond next to or directly on the athletic field and penetrate the subgrade soils, larger soil movements may be experienced than those discussed in this report. The ponding of water or saturated soils can result in the erosion of subgrade and Structural Fill and cause further undesirable differential settlements and distortion of the athletic field above, especially during freeze-thaw cycles. Any free-draining water should be daylighted away from the athletic field surface and perimeter by means of free-draining rock, drain pipes, moisture-wicking geotextile fabric, and/or redesigned site grades. The design of the drainage system is beyond our scope of services. IME advises consulting a contractor experienced in athletic field drainage design.

As per recommendations issued by the track supplier/installer, an interior drain system should be installed outlining the interior edge of the athletic track. This system should capture precipitation runoff from the track and can also be used as a water collection system for the athletic field.

Excavation and replacement with granular structural fill below foundations may cause water to collect within the granular material as water is confined by the less permeable cohesive soils found at the bottom and walls of the excavation. The result of this collected water is commonly referred to as a "bathtub" condition. This collected water can cause the expansion or softening of the clay subgrade soils, which often results in foundation distress. Use of a *clay cap* to cover areas with granular fill should be used to reduce the potential for a bathtub condition. The clay cap should extend a minimum of 3 feet beyond granular fill areas and at least 5 feet beyond the perimeter of the structure foundations with a minimum thickness of

16 inches. The clay cap should consist of a cohesive clay with a plasticity index (PI) between 18 and 25 percent, with at least 70 percent by weight passing the No. 200 Sieve and no more than 15 percent by weight retained on the No. 4 Sieve. Concrete flatwork or pavement extending to the edge of the structure foundation may be used in lieu of the clay cap.

Depending on final grades, groundwater conditions at the site may be seasonally relatively high, which may adversely affect foundation performance if not properly controlled. Elevated groundwater levels can lead to instability of excavations, softening of bearing soils, and, if high enough, potential buoyancy forces acting on foundations and seepage, particularly where structural elements extend below the static water table. To mitigate these risks, a well-designed and properly maintained dewatering system will be essential. The system should be capable of maintaining the groundwater level at least 2 feet below the bottom of all foundation excavations during construction. Continuous monitoring and adjustment of the dewatering system will likely be required as excavation progresses. In addition, the design should incorporate a sump and pump arrangement or other means of active water control to maintain the lowered groundwater level throughout foundation installation and post-construction

To reduce the potential for surface water to impact foundation bearing soils within the portion of the building where the basement is located, installation of a perimeter drainage system is recommended. The drainage system should be constructed around the exterior perimeter of the building foundation and sloped at a minimum 1/8 inch per foot to a suitable outlet providing positive drainage. The drainage system should consist of a properly sized perforated pipe (minimum 4-inch I.D.) embedded in free-draining gravel and placed in a trench at least 12 inches in width and height. The top 1 foot of backfill should be a low permeability soil. The system should be underlain with a polyethylene moisture barrier, sealed to the foundation walls, and extended at least to the edge of the backfill zone. The gravel should be encapsulated with drainage fabric prior to placement of remaining foundation backfill. Design of the drainage system is beyond our scope of services; however, see figure 1 for a drainage detail example.

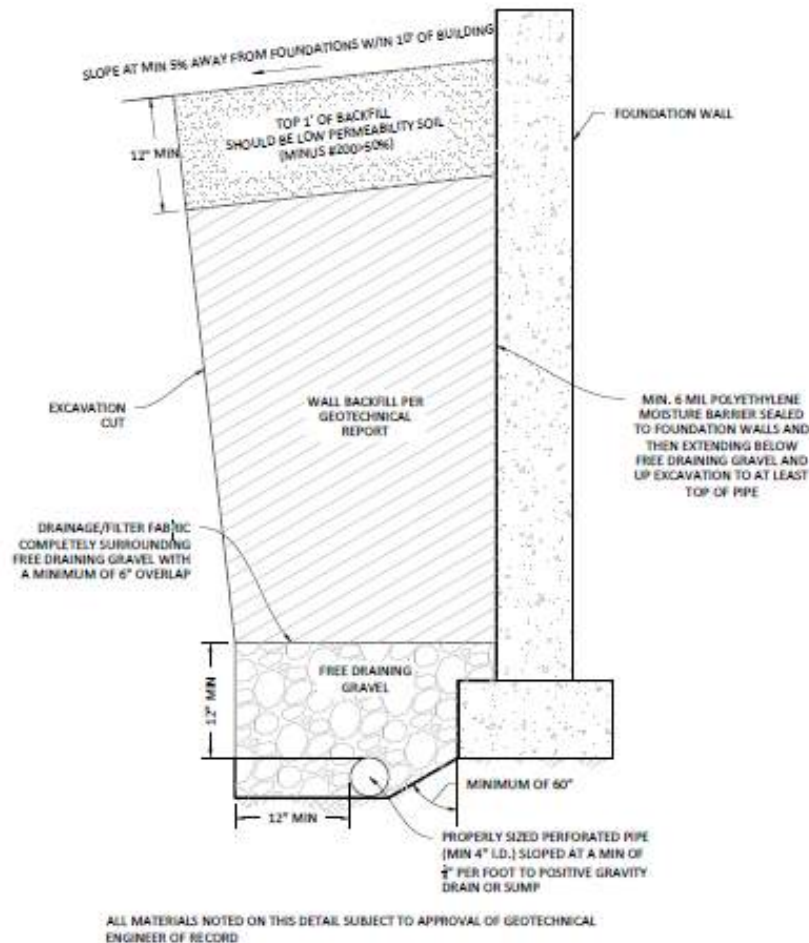


Figure 1: Foundation Drain Detail Example

### 3.10 GENERAL

|                                                |                                                                            |
|------------------------------------------------|----------------------------------------------------------------------------|
| Cement Type                                    |                                                                            |
| Dissolved Sulfate in Water (ppm)               | 1,000ppm ≤ W.S.S. < 2,000ppm                                               |
| Ordinary Portland Cement (OPC)                 | Type II (ASTM C150)                                                        |
| Portland Limestone Cement (PLC)                | Type IL/MS (ASTM C595)                                                     |
| International Building Code Seismic Site Class | Site Class D                                                               |
| Site Surface Drainage                          | See Section 3.9 – Site Drainage                                            |
| Seepage Protection                             | Potential seepage should be captured and directed away from the excavation |
| Landscaping and Irrigation                     | Minimized or eliminated within 10 feet of the structure.                   |

According to ACI 318-19, sulfate exposure classes that require the use of Type II or Type IL/MS cement as recommended in the table above should have a minimum compressive strength of 4,000 psi and a maximum water-to-cement ratio of 0.50.

Inberg-Miller Engineers should review final plans and specifications in order to determine whether the intent of our recommendations has been properly implemented. In addition, we should be retained as the geotechnical engineer and construction materials testing agency to provide the following services:

- a. Observe excavations to determine if the subsurface conditions revealed are consistent with those discovered in the exploration.
- b. Identify if the proper bearing stratum is exposed at the proposed foundation excavation depths.
- c. Observe that foundation excavations are properly prepared, cleaned, and dewatered prior to concrete placement.
- d. Test compaction of subgrades and fills.
- e. Perform field and laboratory testing of concrete and other materials as required by project specification and/or building code.

### 3.11 CONSTRUCTION

|                                   |                                                                                                                                                                    |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Excavation Difficulty             | Moderate – Conventional excavation equipment should be adequate.<br>Excavation of EAPs at depth will increase in difficulty and should be considered accordingly.  |
| Dewatering Requirements           | Dependent on final site elevations, seasonal groundwater elevations, and surface runoff, preparation for dewatering is recommended.                                |
| Soil Sensitivity                  | Low to Moderate – clay and silt presence will require careful application of water for compaction.                                                                 |
| OSHA Soil Type                    | OSHA Type C– See Below                                                                                                                                             |
| Potential for Buried Obstructions | Moderate to High – Existing site structures                                                                                                                        |
| Protection of Existing Structures | Excavations should not extend below a 2H:1V projection below the existing foundations without proper shoring or support designed by a licensed Structural Engineer |
| On-site Borrow Soil               | Native overburden soil may be used as landscaping and non-structural fill                                                                                          |

Excavations should be sloped, benched, shored, or made safe for entry by the use of trench boxes, as required by the standards of 29 CFR Part 1926. As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance equal to the slope height, from the crest of the slope. The contractor is solely responsible for designing and constructing stable excavations, the geometry of the excavation slopes, and the protective equipment and procedures employed by his forces. For the sole purpose of project planning, we recommend that clay, sand, and silt soils are considered an OSHA Type C soil. Excavations, including utility trenches, extending to depths of greater than 20 feet, are required to have side slopes, trench boxes, or shoring designed by a professional engineer licensed in the state of Wyoming.

#### **4.0 TECHNICAL DATA**

Our Sample and Data Collection Information, Site and Boring Location Map, Photographs, and Test Boring Logs are included in Appendix A.

#### **5.0 STANDARD REPORT INFORMATION**

Our Field and Laboratory Testing Program and Testing Data (laboratory reports) are included in Appendix B.

Our Standard Report Information, including Terms and Definitions, Limitations, and Comments Form, are included in Appendix C.

#### **6.0 CLOSURE**

This report has been prepared for the exclusive use of our client, Plan One Architects, for evaluation of the site, design, and construction planning purposes of the described project. All information referenced in the Table of Contents, as well as any future written documents that address comments or questions regarding this report, constitute the "entire report." Inberg-Miller Engineers' conclusions, opinions, and recommendations are based on the entire report. This report may contain insufficient information for applications other than those herein described. Our scope of services was specifically designed for and limited to the specific purpose of providing geotechnical recommendations for the design of the proposed Campbell County High School project. Consequently, this report may contain insufficient information for applications other than those herein described.

The recommendations in this report are based on the subsurface conditions encountered at the test borings at the time they were drilled. The readers of this geotechnical engineering report should realize that subsurface variations and anomalies can and will exist across the site and between the test borings. The readers should also realize that site conditions will change due to the modifying effects of seasonal, climatic and construction conditions.

We caution that this report was not written as a construction contract document, and therefore should either not be incorporated in contract documents or be accompanied by a statement similar to the following:

*This report was used during the planning and design of the subject project and is provided in the contract documents for informational purposes only. This report may contain recommendations that were not implemented and terms that conflict with the contract documents, therefore, the project plans and technical specifications, and not this report, should be followed for construction requirements.*

We appreciate participating in your project. We can offer services under a separate contract to provide civil or environmental engineering services, review final plans and specifications, perform construction surveying, field and laboratory construction materials testing, and observe excavations, as may be required. Please call our Gillette office at 307-682-5000 if you have any questions regarding this report.

## Appendix A

---

## **SAMPLE AND DATA COLLECTION INFORMATION**

Field-sampling techniques were employed in this exploration to obtain the data presented in the Final Logs and Report generally in accordance with ASTM D420, D1452, D1586 (where applicable), and D1587 (where applicable).

The drilling method utilized in most test borings is a dry-process, machine rotary auger type that advances hollow steel pipe surrounded by attached steel auger flights in 5-foot lengths. This method creates a continuously cased test hole that prevents the boring from caving in above each level of substrata to be tested. Sampling tools were lowered inside the hollow shaft for testing in the undisturbed soils below the lead auger. In some test borings, as appropriate to advance to the desired depth, air or wash rotary drilling methods were utilized. Air or wash rotary drilling methods allow for the extraction of rock core samples.

Samples were brought to the surface, examined by an IME field representative, and sealed in containers (or sealed in the tubes) to prevent a significant loss of moisture. They were returned to our laboratory for final classification per ASTM D2487 methods. Some samples were subjected to field or laboratory tests as described in the text of this report.

Groundwater observations were made in the open drill holes by IME field personnel at the times and dates stated on the Final Logs. Recorded groundwater levels may not reflect equilibrium groundwater conditions due to relatively low permeability of some soils. It must also be noted that fluctuations may occur in the groundwater level due to variations in precipitation, temperature, nearby site improvements, nearby drainage features, underdrainage, wells, severity of winter frosts, overburden weights, and the permeability of the subsoil. Because variations may be expected, final designs and construction planning should allow for the need to temporarily or permanently dewater excavations or subsoil.

A Final Log of each test pit or boring was prepared by IME. Each Final Log contains IME's interpretation of field conditions or changes in substrata between recovered samples based on the field data received, along with the laboratory test data obtained following the field work or on subsequent site observations. The final logs were prepared by assembling and analyzing field and laboratory data. Therefore, the Final Logs contain both factual and interpretive information. IME's opinions are based on the Final Logs.

The Final Logs list boring methods, sampling methods, approximate depths sampled, amounts of recovery in sampling tools (where applicable), indications of the presence of subsoil types, and groundwater observations and measurements. Results of some laboratory tests are arrayed on the Final Logs at the appropriate depths below grade. The horizontal lines on the Final Logs designate the interface between successive layers (strata) and represent approximate boundaries. The transition between strata may be gradual.

We caution that the Final Logs alone do not constitute the report, and as such they should not be excerpted from the other appendix exhibits or from any of the written text. Without the written report, it is possible to misinterpret the meaning of the information reported on the Final Logs. If the report is

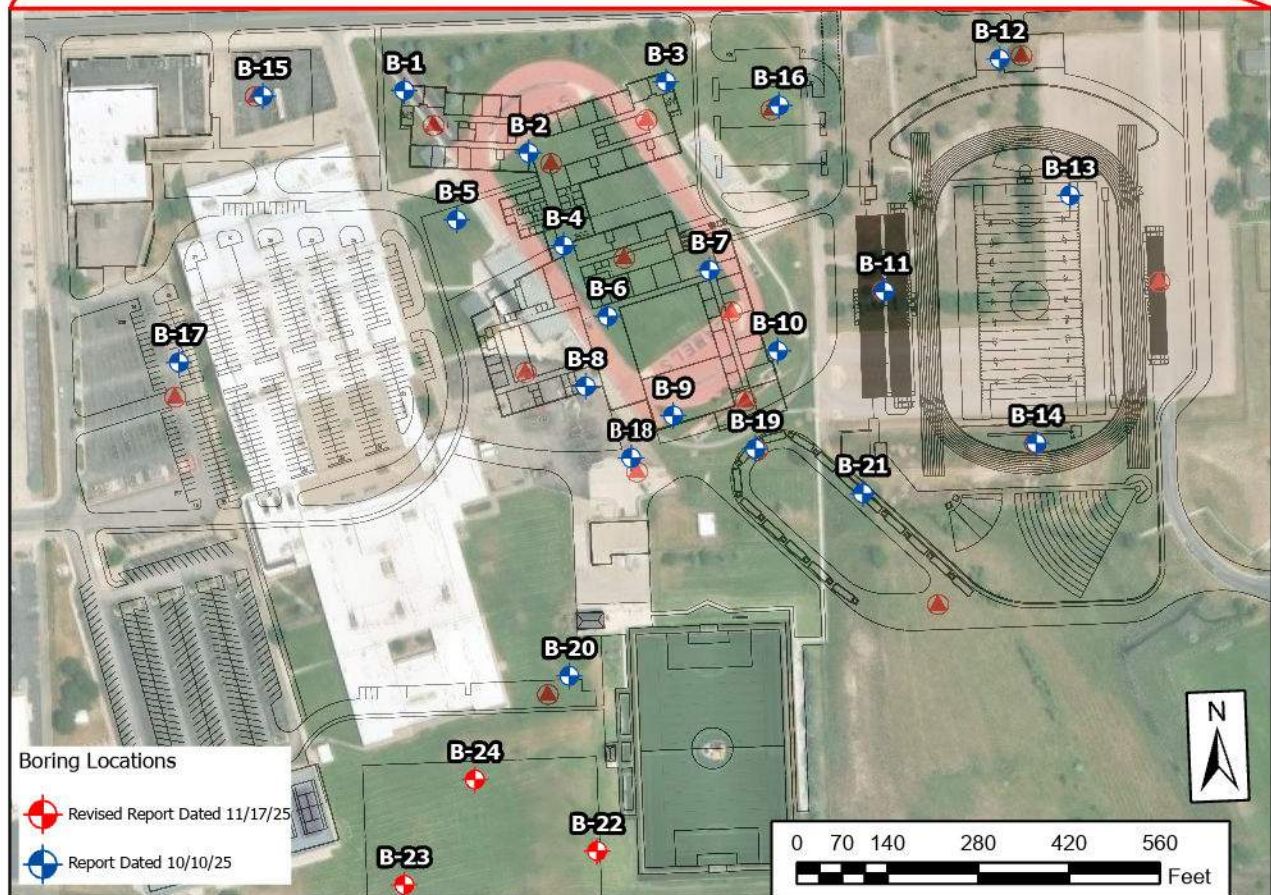
---

reproduced for reference purposes, the entire numbered report and appendix exhibits should be bound together as a separate document, or as a section of a specification booklet, including all drawings, maps, etc.

Pocket penetration tests taken in the field, or on samples examined in the laboratory are listed on the Final Logs in a column marked "qp." These tests were performed only to approximate unconfined strength and consistency when making comparisons between successive layers of cohesive soil. It is not recommended that the listed values be used to determine allowable bearing capacities. Bearing capacities of soil is determined by IME using test methods as described in the text of the report.



## CCHS Borings - Site Location



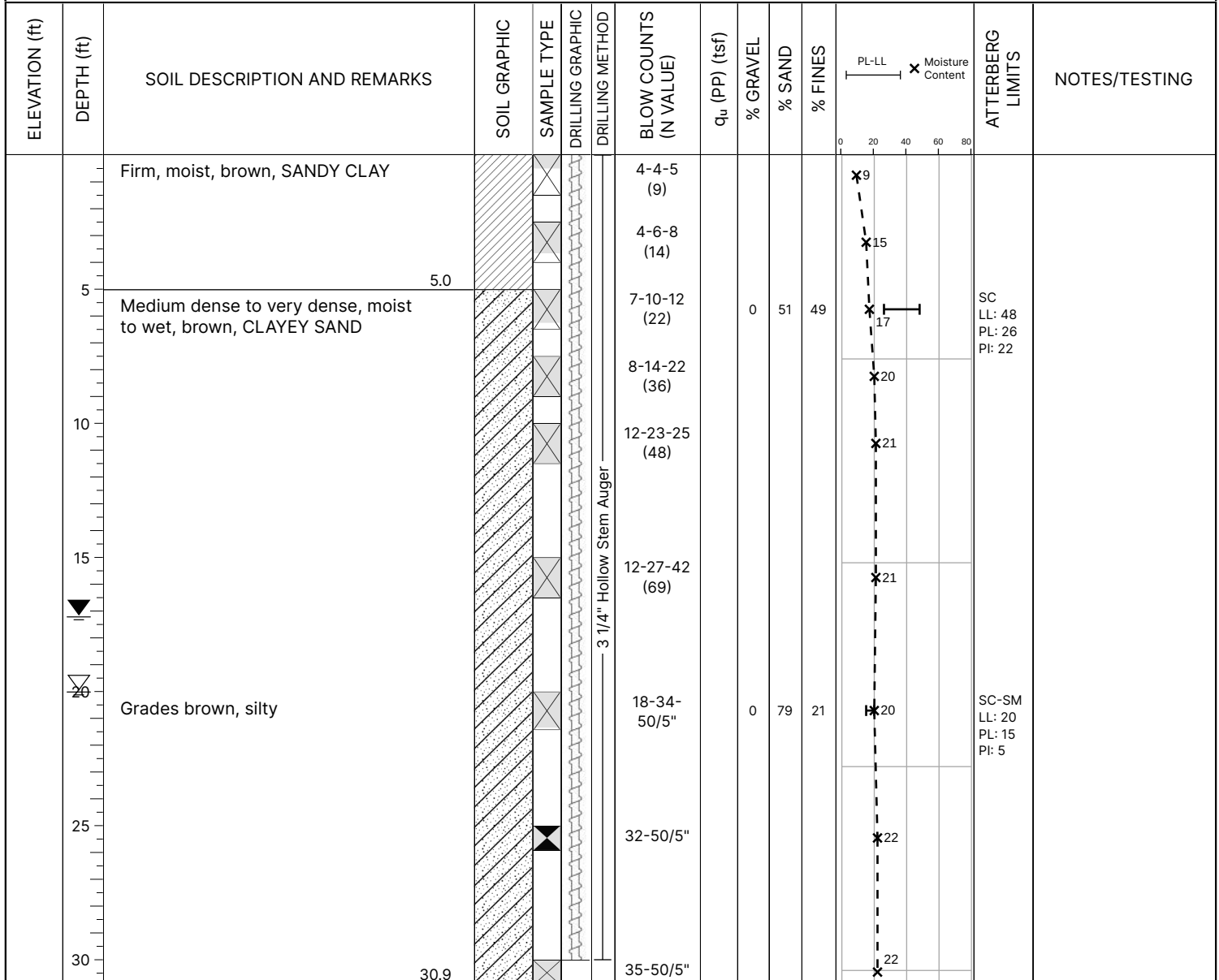
Vendor: Esri, NASA, NGA, USGS, Sources: Esri, USGS, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



Location New High School Structure  
Boring Location 44.283611, -105.487500

## Soil Boring: B-1

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One



End of boring at 30.9'

Remarks:

Date Begun: 08/28/2025  
Date Completed: 08/28/2025  
Termination Depth: 30.92'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

SPT - Standard Penetration Test

DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) 20'

After Drilling (AD) 17.2'

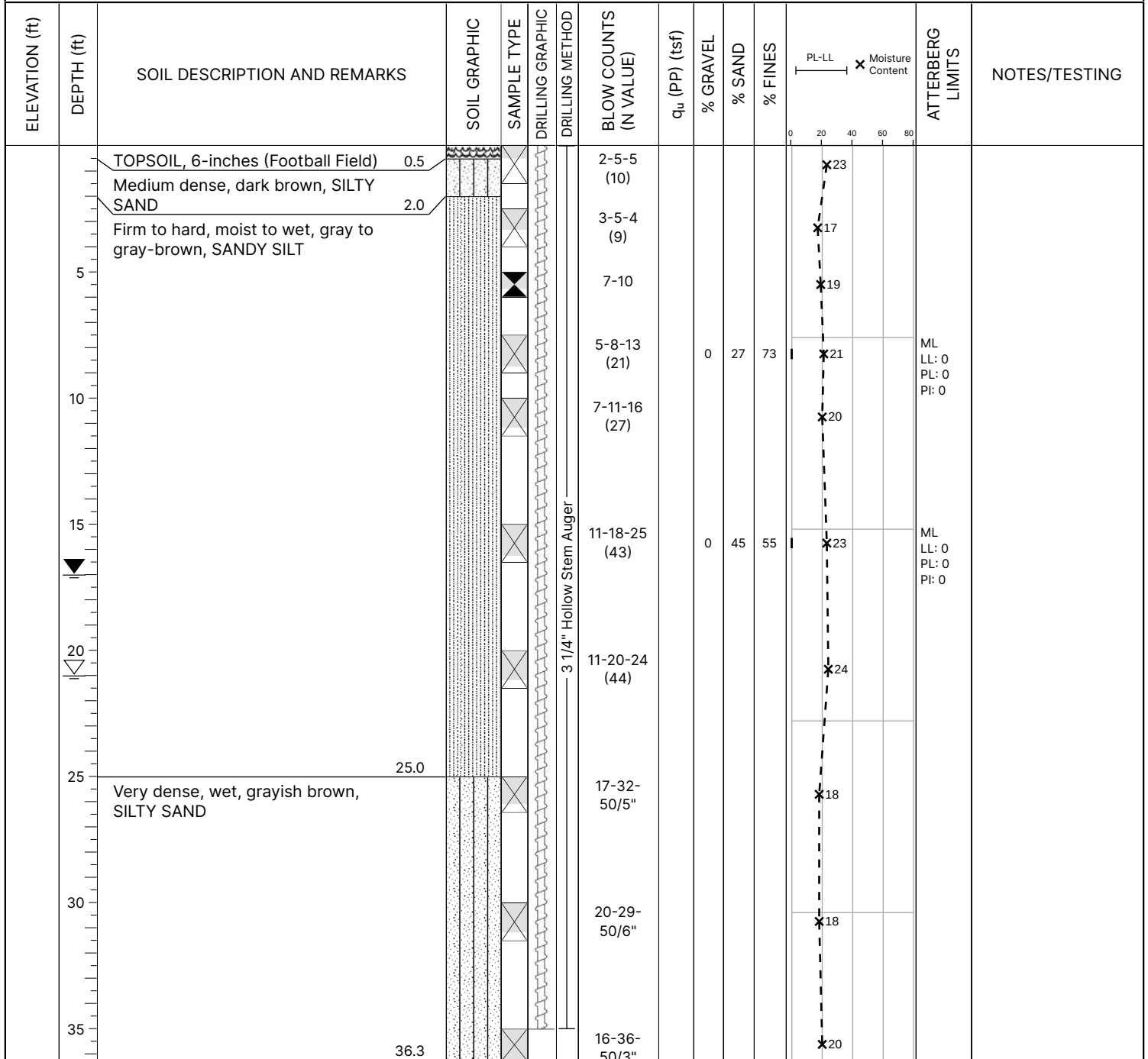
Depth To Cave In: 27.3'



Location New High School Structure  
Boring Location 44.283327, -105.486784

## Soil Boring: B-2

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One



Remarks:

Date Begun: 08/26/2025  
Date Completed: 08/26/2025  
Termination Depth: 36.25'  
Crew: DAW, DAP  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

SPT - Standard Penetration Test  
 DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) 21'  
 After Drilling (AD) 17'

Depth To Cave In: 30'





Location New High School Structure  
Boring Location 44.283604, -105.485960

## Soil Boring: B-3

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                               | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS           | NOTES/TESTING |
|----------------|------------|------------------------------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|-------------------------|----------------------------|---------------|
|                |            | TOPSOIL, 6-inches (Discus Sector) 0.5                      |              | X           |                  |                 | 2-4-6 (10)            |                           |          |        |         |                         |                            |               |
|                |            | Medium dense, moist, brown, CLAYEY SAND                    |              | X           |                  |                 | 2-4-5 (9)             |                           |          |        |         |                         |                            |               |
|                | 5          |                                                            |              | X           |                  |                 | 6-8-9 (17)            |                           |          |        |         |                         |                            |               |
|                |            |                                                            |              | X           |                  |                 | 2-4-5 (9)             |                           |          |        |         |                         |                            |               |
|                | 10         | Firm to hard, moist to wet, brownish gray, SANDY CLAY 10.0 |              | X           |                  |                 | 3-5-8 (13)            | 0                         | 47       | 53     |         |                         | CL: 33<br>LL: 20<br>PI: 13 |               |
|                | 15         |                                                            |              | X           |                  |                 | 13-27                 |                           |          |        |         |                         |                            |               |
|                | 20         |                                                            |              | X           |                  |                 | 9-21-31 (52)          |                           |          |        |         |                         |                            |               |
|                | 25         | Very dense, wet, brownish gray, CLAYEY SAND 25.0           |              | X           |                  |                 | 18-35-49 (84)         |                           |          |        |         |                         |                            |               |
|                | 30         |                                                            |              | X           |                  |                 | 23-40-50/5"           |                           |          |        |         |                         |                            |               |
|                | 31.4       |                                                            |              | X           |                  |                 |                       |                           |          |        |         |                         |                            |               |

End of boring at 31.42'

Remarks:

Date Begun: 08/29/2025  
Date Completed: 08/29/2025  
Termination Depth: 31.42'  
Crew: DAW, DAP  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

SPT - Standard Penetration Test

DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) 30'

After Drilling (AD) 19.2'

Depth To Cave In: 29'



Location New High School Structure  
Boring Location 44.282929, -105.486599

## Soil Boring: B-4

Project Campbell County High School Project No. 25054-LX Client Plan One

| ELEVATION (ft)          | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                             | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD          | BLOW COUNTS (N VALUE) | $q_u$ (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS                | NOTES/TESTING |
|-------------------------|------------|--------------------------------------------------------------------------|--------------|-------------|------------------|--------------------------|-----------------------|------------------|----------|--------|---------|------------------------------------------------------------------------------------------------------------|---------------------------------|---------------|
|                         |            | TOPSOIL, 6-inches (Football Field)                                       | 0.5          |             |                  |                          | 8-17-15 (32)          |                  |          |        |         |                         |                                 |               |
|                         |            | Dense to loose, moist, dark brown, SILTY SAND, Minor iron oxide staining |              |             |                  |                          | 2-2-3 (5)             |                  |          |        |         |                         |                                 |               |
|                         | 5          |                                                                          |              |             |                  |                          | 2-2-2 (4)             | 0                | 68       | 32     |         |                         | SM<br>LL: 20<br>PL: 17<br>PI: 3 |               |
|                         |            | Grades medium dense                                                      |              |             |                  |                          | 8-15                  |                  |          |        |         |                         |                                 |               |
|                         | 10         |                                                                          | 11.0         |             |                  |                          | 8-17-26 (43)          |                  |          |        |         |                         |                                 |               |
|                         |            | Hard, moist to wet, gray, SANDY SILT<br>Minor iron oxide staining        |              |             |                  |                          | 8-14-26 (40)          | 0                | 43       | 56     |         |                         | ML<br>LL: 0<br>PL: 0<br>PI: 0   |               |
|                         | 15         |                                                                          |              |             |                  | 3 1/4" Hollow Stem Auger | 18-33-40 (73)         |                  |          |        |         |                         |                                 |               |
|                         | 20         |                                                                          |              |             |                  |                          | 13-32-50/6"           |                  |          |        |         |                       |                                 |               |
|                         | 25         | Very dense, wet, gray, SILTY SAND                                        | 25.0         |             |                  |                          | 35-50/5"              |                  |          |        |         |                       |                                 |               |
|                         | 30         |                                                                          |              |             |                  |                          | 25-41-50/3"           |                  |          |        |         |                       |                                 |               |
|                         | 35         |                                                                          | 36.3         |             |                  |                          |                       |                  |          |        |         |                                                                                                            |                                 |               |
| End of boring at 36.25' |            |                                                                          |              |             |                  |                          |                       |                  |          |        |         |                                                                                                            |                                 |               |

Remarks:

Date Begun: 08/26/2025  
Date Completed: 08/26/2025  
Termination Depth: 36.25'  
Crew: DAW, DAP  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

 SPT - Standard Penetration Test

 DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

 At Time of Drilling (ATD) 20'

 After Drilling (AD) 17.3'

Depth To Cave In: 29.3'



Location New High School Structure  
Boring Location 44.283056, -105.487222

## Soil Boring: B-5

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                       | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL<br>Moisture Content | ATTERBERG LIMITS | NOTES/TESTING |
|----------------|------------|--------------------------------------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|---------------------------|------------------|---------------|
|                |            | TOPSOIL, 6-inches                                                  |              |             |                  |                 | 2-3-2<br>(5)          |                           |          |        |         |                           |                  |               |
|                | 0.5        | Soft, moist, brown, SANDY CLAY                                     |              |             |                  |                 | 3-9-14<br>(23)        |                           |          |        |         |                           |                  |               |
|                | 2.5        | Medium dense to very dense, moist to wet, light brown, CLAYEY SAND |              |             |                  |                 | 9-11-14<br>(25)       |                           |          |        |         |                           |                  |               |
|                | 5          |                                                                    |              |             |                  |                 | 9-9-12<br>(21)        | 0                         | 86       | 14     |         |                           |                  |               |
|                | 10         | Grades reddish gray, higher clay content                           |              |             |                  |                 | 14-17-14<br>(31)      |                           |          |        |         |                           |                  |               |
|                | 15         | Grades gray                                                        |              |             |                  |                 | 12-19-32<br>(51)      | 0                         | 52       | 48     |         |                           |                  |               |
|                | 20         |                                                                    |              |             |                  |                 | 22-37                 |                           |          |        |         |                           |                  |               |
|                | 25         |                                                                    |              |             |                  |                 | 28-50/6"              |                           |          |        |         |                           |                  |               |
|                | 30         |                                                                    |              |             |                  |                 | 26-50/6"              |                           |          |        |         |                           |                  |               |
|                | 31.0       |                                                                    |              |             |                  |                 |                       |                           |          |        |         |                           |                  |               |

End of boring at 31'

Remarks:

Date Begun: 08/28/2025  
Date Completed: 08/28/2025  
Termination Depth: 31.0'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test



DM - Dames and Moore

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)



After Drilling (AD)

20'

11'

Depth To Cave In: 26.5'





Location New High School Structure  
Boring Location 44.282801, -105.485748

## Soil Boring: B-7

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft)         | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                    | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD          | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL | Moisture Content | ATTERBERG LIMITS                 | NOTES/TESTING |
|------------------------|------------|-------------------------------------------------|--------------|-------------|------------------|--------------------------|-----------------------|---------------------------|----------|--------|---------|-------|------------------|----------------------------------|---------------|
|                        |            | TOPSOIL, 6-inches (Football Field)              | 0.5          |             |                  |                          | 2-2-3 (5)             |                           |          |        |         |       |                  |                                  |               |
|                        |            | Soft to hard, moist, dark brown to gray, CLAY   |              |             |                  |                          | 5-8-8 (16)            |                           |          |        |         |       |                  |                                  |               |
|                        | 5          | Grades black with odor (potential hydrocarbons) |              |             |                  |                          | 4-7-9 (16)            |                           |          |        |         |       |                  |                                  |               |
|                        |            | Grades brown to gray                            |              |             |                  |                          | 4-7-11 (18)           | 0                         | 31       | 69     |         |       |                  | CL<br>LL: 49<br>PL: 18<br>PI: 31 |               |
|                        | 10         |                                                 |              |             |                  |                          | 8-11                  |                           |          |        |         |       |                  |                                  |               |
|                        | 15         |                                                 |              |             |                  |                          | 6-13-19 (32)          |                           |          |        |         |       |                  |                                  |               |
|                        | 18.0       | Hard, wet, brown to gray, CLAYEY SILT           |              |             |                  | 3 1/4" Hollow Stem Auger | 20-40-50/4"           | 2                         | 43       | 55     |         |       |                  | ML<br>LL: 0<br>PL: 0<br>PI: 0    |               |
|                        | 25.0       | Very dense, wet, tan to light brown, SILTY SAND |              |             |                  |                          | 15-24-41 (65)         |                           |          |        |         |       |                  |                                  |               |
|                        | 30         |                                                 |              |             |                  |                          | 23-42-50/4"           |                           |          |        |         |       |                  |                                  |               |
|                        | 36.3       |                                                 |              |             |                  |                          | 22-35-50/4"           |                           |          |        |         |       |                  |                                  |               |
| End of boring at 36.3' |            |                                                 |              |             |                  |                          |                       |                           |          |        |         |       |                  |                                  |               |

Remarks:

Date Begun: 08/26/2025  
Date Completed: 08/26/2025  
Termination Depth: 36.33'  
Crew: DAW, DAP  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

⊗ SPT - Standard Penetration Test

⊗ DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

▽ At Time of Drilling (ATD) 22'

▽ After Drilling (AD) 18'

Depth To Cave In: 30.7'

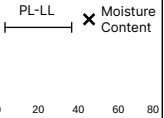




Location New High School Structure  
Boring Location 44.282331, -105.486503

## Soil Boring: B-8

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                             | SOIL GRAPHIC                                                                        | SAMPLE TYPE                                                                         | DRILLING GRAPHIC                                                                    | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  | ATTERBERG LIMITS                   | NOTES/TESTING |
|----------------|------------|----------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|-------------------------------------------------------------------------------------------|------------------------------------|---------------|
|                |            | ASPHALT, 4-inches 0.3                                    |    |    |    |                 | 8-14-19 (33)          |                           |          |        |         |        |                                    |               |
|                |            | Medium dense to very dense, moist, brown, SILTY SAND 4.0 |    |    |    |                 | 16-27-37 (64)         | 1                         | 88       | 11     |         |        | SM<br>LL: 0<br>PL: 0<br>PI: 0      |               |
|                | 5          | Very dense, moist to wet, brownish gray, CLAYEY SAND     |    |    |    |                 | 15-30-43 (73)         |                           |          |        |         |        |                                    |               |
|                |            |                                                          |    |    |    |                 | 16-29-40 (69)         |                           |          |        |         |        |                                    |               |
|                | 10         |                                                          |    |    |    |                 | 12-28-39 (67)         |                           |          |        |         |        |                                    |               |
|                | 15         |                                                          |    |    |    |                 | 20-35-48 (83)         | 1                         | 84       | 15     |         |        | SC-SM<br>LL: 25<br>PL: 18<br>PI: 7 |               |
|                | 20         |                                                          |    |    |    |                 | 22-45                 |                           |          |        |         |        |                                    |               |
|                | 25         |                                                          |   |   |   |                 | 27-50/6"              |                           |          |        |         |      |                                    |               |
|                | 30         |                                                          |  |  |  |                 | 23-50/6"              |                           |          |        |         |      |                                    |               |
|                | 31.0       |                                                          |  |  |  |                 |                       |                           |          |        |         |                                                                                           |                                    |               |

End of boring at 31'

Remarks:

Date Begun: 08/28/2025  
Date Completed: 08/28/2025  
Termination Depth: 31.0'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

#### SAMPLE TYPES



SPT - Standard Penetration Test



DM - Dames and Moore

#### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)



After Drilling (AD)

15'

11'

Depth To Cave In: 26.6'



Location New High School Structure  
Boring Location 44.282193, -105.485995

## Soil Boring: B-9

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                               | SOIL GRAPHIC | SAMPLE TYPE | DRILLING METHOD          | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL | Moisture Content | ATTERBERG LIMITS              | NOTES/TESTING |
|----------------|------------|------------------------------------------------------------|--------------|-------------|--------------------------|-----------------------|---------------------------|----------|--------|---------|-------|------------------|-------------------------------|---------------|
|                |            | TOPSOIL, 6-inches                                          | 0.5          |             |                          | 1-3-5 (8)             |                           |          |        |         |       |                  |                               |               |
|                |            | Medium dense, moist, light brown, CLAYEY SAND              | 3.0          |             |                          | 3-3-5 (8)             |                           |          |        |         |       |                  |                               |               |
|                | 5          | Medium dense to very dense, moist, light brown, SILTY SAND |              |             |                          | 3-4-5 (9)             |                           |          |        |         |       |                  |                               |               |
|                |            | Moisture increase                                          |              |             |                          | 2-1-1 (2)             |                           |          |        |         |       |                  |                               |               |
|                | 10         |                                                            |              |             |                          | 3-11-19 (30)          |                           |          |        |         |       |                  |                               |               |
|                | 15         | Minor iron oxide staining                                  |              |             |                          | 19-35-50/4"           |                           | 0        | 86     | 14      |       |                  | SM<br>LL: 0<br>PL: 0<br>PI: 0 |               |
|                | 20         |                                                            |              |             | 3 1/4" Hollow Stem Auger | 29-45                 |                           |          |        |         |       |                  |                               |               |
|                | 25         |                                                            |              |             |                          | 25-50/6"              |                           |          |        |         |       |                  |                               |               |
|                | 30         | Grades grayish brown                                       |              |             |                          | 29-50/4"              |                           |          |        |         |       |                  |                               |               |
|                | 35         | Grades gray                                                | 36.4         |             |                          | 25-32-50/5"           |                           |          |        |         |       |                  |                               |               |

End of boring at 36.4'

Remarks:

Date Begun: 08/27/2025  
Date Completed: 08/27/2025  
Termination Depth: 36.42'  
Crew: DAW, DAP  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

⊗ SPT - Standard Penetration Test

⊗ DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

▽ At Time of Drilling (ATD) None

▽ End of Drilling (EOD) None

Depth To Cave In: 29.2'



Location New High School Structure  
Boring Location 44.282448, -105.485365

## Soil Boring: B-10

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                  | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD          | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS                 | NOTES/TESTING |
|----------------|------------|---------------------------------------------------------------|--------------|-------------|------------------|--------------------------|-----------------------|---------------------------|----------|--------|---------|-------------------------|----------------------------------|---------------|
|                |            | TOPSOIL, 6-inches 0.5                                         |              |             |                  | 3 1/4" Hollow Stem Auger | 1-4-3 (7)             |                           |          |        |         | 19                      | SC<br>LL: 41<br>PL: 23<br>PI: 18 |               |
|                |            | Loose to medium dense, moist to wet, light brown, CLAYEY SAND |              |             |                  |                          | 4-5-4 (9)             |                           |          |        |         | 15                      |                                  |               |
|                |            | 2" layer of clay                                              |              |             |                  |                          | 4-7                   |                           |          |        |         | 20                      |                                  |               |
|                |            | Grades dark gray                                              |              |             |                  |                          | 3-6-6 (12)            | 0                         | 65       | 35     |         | 14                      |                                  |               |
|                |            |                                                               |              |             |                  |                          | 3-3-4 (7)             |                           |          |        |         | 18                      |                                  |               |
|                |            | Grades light brown                                            |              |             |                  |                          | 5-10-12 (22)          |                           |          |        |         | 26                      |                                  |               |
|                |            |                                                               |              |             |                  |                          | 25-31-50/5"           |                           |          |        |         | 23                      |                                  |               |
|                |            | Hard, wet, brownish gray, SANDY SILT 20.0                     |              |             |                  |                          | 18-33-50/5"           | 2                         | 70       | 29     |         | 24                      | SM<br>LL: 0<br>PL: 0<br>PI: 0    |               |
|                |            | Very dense, wet, light brown, SILTY SAND 25.0                 |              |             |                  |                          | 20-30-50/5"           |                           |          |        |         | 19                      |                                  |               |
|                |            | 31.4                                                          |              |             |                  |                          |                       |                           |          |        |         |                         |                                  |               |

End of boring at 31.4'

Remarks:

Date Begun: 08/27/2025  
Date Completed: 08/27/2025  
Termination Depth: 31.42'  
Crew: DAW, DAP  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

SPT - Standard Penetration Test

DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) 20'

After Drilling (AD) 11.5'

Depth To Cave In: 12.2'



Location New Athletic Facilities  
Boring Location 44.282682, -105.484725

# Soil Boring: B-11

Project Campbell County High School Project No. 25054-LX Client Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                        | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL | Moisture Content | ATTERBERG LIMITS | NOTES/TESTING |
|----------------|------------|-----------------------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|-------|------------------|------------------|---------------|
|                |            | TOPSOIL, 6-inches                                   | 0.5          |             |                  |                 | 8-15-15 (30)          |                           |          |        |         |       |                  |                  |               |
|                |            | Medium dense, moist, light brown, SILTY SAND        |              |             |                  |                 | 7-7-9 (16)            |                           |          |        |         |       |                  |                  |               |
|                | 4.0        |                                                     |              |             |                  |                 | 2-2-4 (6)             |                           |          |        |         |       |                  |                  |               |
|                | 5          | Soft to hard, moist, brown to gray, SANDY SILT      |              |             |                  |                 | 4-5                   |                           |          |        |         |       |                  |                  |               |
|                | 10         |                                                     |              |             |                  |                 | 7-10-16 (26)          | 0                         | 34       | 66     |         |       |                  |                  |               |
|                | 15         |                                                     |              |             |                  |                 | 12-21-31 (52)         |                           |          |        |         |       |                  |                  |               |
|                | 18.0       |                                                     |              |             |                  |                 | 12-18-28 (46)         |                           |          |        |         |       |                  |                  |               |
|                | 20         | Dense to very dense, moist to wet, gray, SILTY SAND |              |             |                  |                 | 19-32-43 (75)         |                           |          |        |         |       |                  |                  |               |
|                | 25         |                                                     |              |             |                  |                 | 18-40-50/5"           |                           |          |        |         |       |                  |                  |               |
|                | 30         | Minor iron oxide staining                           |              |             |                  |                 |                       |                           |          |        |         |       |                  |                  |               |
|                | 31.4       |                                                     |              |             |                  |                 |                       |                           |          |        |         |       |                  |                  |               |

End of boring at 31.4'

Remarks:

Date Begun: 08/28/2025  
Date Completed: 08/28/2025  
Termination Depth: 31.42'  
Crew: DAW, DAP  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

## SAMPLE TYPES

- ⊗ SPT - Standard Penetration Test  
⊗ DM - Dames and Moore

## WATER LEVEL OBSERVATIONS

- ▽ At Time of Drilling (ATD) 21'  
▽ After Drilling (AD) 17'

Depth To Cave In: 30'



Location New Athletic Facilities  
Boring Location 44.283644, -105.483992

## Soil Boring: B-12

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                        | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL<br>Moisture Content | ATTERBERG LIMITS              | NOTES/TESTING                   |
|----------------|------------|---------------------------------------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|---------------------------|-------------------------------|---------------------------------|
|                |            | TOPSOIL, 6-inches 0.5                                               |              | X           |                  |                 | 3-4-4 (8)             |                           |          |        |         | X3                        |                               | Hazard Glass in sample          |
|                |            | Medium dense to very dense, moist, light brown to brown, SILTY SAND |              | X           |                  |                 | 6-7-9 (16)            |                           |          |        |         | X4                        |                               |                                 |
|                | 5          |                                                                     |              | X           |                  |                 | 6-9-8 (17)            |                           |          |        |         | X5                        |                               |                                 |
|                |            |                                                                     |              | X           |                  |                 | 6-7-8 (15)            | 0                         | 78       | 22     |         | X5                        | SM<br>LL: 0<br>PL: 0<br>PI: 0 |                                 |
|                | 10         |                                                                     |              | X           |                  |                 | 5-9-9 (18)            |                           |          |        |         | X5                        |                               | Roots, trees, and Shrubs nearby |
|                | 15         |                                                                     |              | X           |                  |                 | 20-36                 |                           |          |        |         | X5                        |                               |                                 |
|                | 20         | Grades gray 21.3                                                    |              | X           |                  |                 | 23-36-50/4"           |                           |          |        |         | X8                        |                               |                                 |

End of boring at 21.33'

Remarks:

Date Begun: 08/27/2025  
Date Completed: 08/27/2025  
Termination Depth: 21.33'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test



DM - Dames and Moore

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)



End of Drilling (EOD)

None

None

Depth To Cave In: 19'



Location New Athletic Facilities  
Boring Location 44.283056, -105.483611

## Soil Boring: B-13

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                  | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL | Moisture Content | ATTERBERG LIMITS | NOTES/TESTING |
|----------------|------------|---------------------------------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|-------|------------------|------------------|---------------|
|                |            | ASPHALT, 4-inches 0.3                                         |              |             |                  |                 | 4-4-3 (7)             |                           |          |        |         |       |                  |                  |               |
|                |            | AGGREGATE ROAD BASE, 6-inches 0.8                             |              |             |                  |                 | 1-1-3 (4)             |                           |          |        |         |       |                  |                  |               |
|                |            | Loose to very dense, moist to wet, brown to gray, CLAYEY SAND |              |             |                  |                 | 5-7-9 (16)            | 0                         | 76       | 24     |         |       |                  |                  |               |
|                | 5          |                                                               |              |             |                  |                 | 8-10-15 (25)          |                           |          |        |         |       |                  |                  |               |
|                | 10         |                                                               |              |             |                  |                 | 15-24-29 (53)         |                           |          |        |         |       |                  |                  |               |
|                | 15         |                                                               |              |             |                  |                 | 17-34                 |                           |          |        |         |       |                  |                  |               |
|                | 20         |                                                               |              |             |                  |                 | 17-34-50/5.5"         |                           |          |        |         |       |                  |                  |               |
|                | 21.5       |                                                               |              |             |                  |                 |                       |                           |          |        |         |       |                  |                  |               |

End of boring at 21.46'

Remarks:

Date Begun: 08/29/2025  
Date Completed: 08/29/2025  
Termination Depth: 21.46'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test



DM - Dames and Moore

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)



After Drilling (AD)

20'

17'

Depth To Cave In: 18.5'



Location New Athletic Facilities  
Boring Location 44.282015, -105.483868

## Soil Boring: B-14

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL | Moisture Content | ATTERBERG LIMITS                 | NOTES/TESTING |
|----------------|------------|-------------------------------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|-------|------------------|----------------------------------|---------------|
|                |            | TOPSOIL, 6-inches                                           | 0.5          |             |                  |                 | 3-5-7 (12)            |                           |          |        |         |       |                  |                                  |               |
|                | 5          | Firm to soft, moist, brown, SANDY SILT                      |              |             |                  |                 | 7-7-7 (14)            |                           |          |        |         |       |                  |                                  |               |
|                | 7.5        | Medium dense to very loose, moist to wet, brown, SILTY SAND |              |             |                  |                 | 2-4-6 (10)            | 0                         | 37       | 63     |         |       |                  | MH<br>LL: 50<br>PL: 31<br>PI: 19 |               |
|                | 10         |                                                             |              |             |                  |                 | 2-3-4 (7)             |                           |          |        |         |       |                  |                                  |               |
|                | 15         |                                                             |              |             |                  |                 | 3-3-8 (11)            | 0                         | 84       | 16     |         |       |                  | SM<br>LL: 0<br>PL: 0<br>PI: 0    |               |
|                | 20         | Grades very dense, black                                    | 21.0         |             |                  |                 | 2-1-1 (2)             |                           |          |        |         |       |                  |                                  |               |
|                |            |                                                             |              |             |                  |                 | 29-50/6"              |                           |          |        |         |       |                  |                                  |               |

End of boring at 21'

Remarks:

Date Begun: 08/29/2025  
Date Completed: 08/29/2025  
Termination Depth: 21.0'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

☒ SPT - Standard Penetration Test

### WATER LEVEL OBSERVATIONS

▽ At Time of Drilling (ATD) 15'

▽ After Drilling (AD) 11'

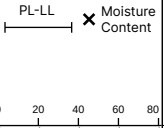
Depth To Cave In: 18'



Location New Pavement Areas  
Boring Location 44.283611, -105.488333

## Soil Boring: B-15

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                    | SOIL GRAPHIC                                                                      | SAMPLE TYPE | DRILLING GRAPHIC                                                                  | DRILLING METHOD          | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS           | NOTES/TESTING |
|----------------|------------|-------------------------------------------------|-----------------------------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------|--------------------------|-----------------------|---------------------------|----------|--------|---------|------------------------------------------------------------------------------------------------------------|----------------------------|---------------|
|                |            | ASPHALT, 4-inches 0.3                           |  |             |  |                          | 3-3-3 (6)             |                           |          |        |         |                                                                                                            |                            |               |
|                |            | AGGREGATE ROAD BASE, 6-inches 0.8               |  |             |  |                          | 2-3-6 (9)             | 0                         | 25       | 75     |         |                                                                                                            |                            |               |
|                | 5          | Soft to stiff, moist, grayish brown, SANDY CLAY |  |             |  | 3 1/4" Hollow Stem Auger | 4-7-11 (18)           |                           |          |        |         |                                                                                                            |                            |               |
|                | 6.5        |                                                 |                                                                                   |             |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            | CL: 38<br>LL: 21<br>PI: 17 |               |

End of boring at 6.5'

Remarks:

Date Begun: 08/29/2025  
Date Completed: 08/29/2025  
Termination Depth: 6.5'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)

None



End of Drilling (EOD)

None

Depth To Cave In: 5'





Location New Pavement Areas  
Boring Location 44.283485, -105.485300

## Soil Boring: B-16

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                                                             | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD          | BLOW COUNTS<br>(N VALUE)                                | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL<br>Moisture Content | ATTERBERG<br>LIMITS           | NOTES/TESTING |
|----------------|------------|----------------------------------------------------------------------------------------------------------|--------------|-------------|------------------|--------------------------|---------------------------------------------------------|---------------------------|----------|--------|---------|---------------------------|-------------------------------|---------------|
|                |            | TOPSOIL, 6-inches<br>Loose to medium dense, moist,<br>light brown, SILTY SAND<br><br>Grades reddish gray |              |             |                  | 3 1/4" Hollow Stem Auger | 2-3-3<br>(6)<br><br>4-6-8<br>(14)<br><br>6-9-13<br>(22) |                           | 0        | 88     | 11      | 9<br>8<br>7               | SM<br>LL: 0<br>PL: 0<br>PI: 0 |               |

End of boring at 6.5'

Remarks:

Date Begun: 08/27/2025  
Date Completed: 08/27/2025  
Termination Depth: 6.5'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)

None



End of Drilling (EOD)

None

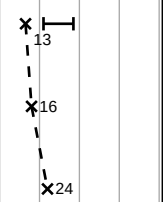
Depth To Cave In: 5'



Location New Pavement Areas  
Boring Location 44.282500, -105.488889

## Soil Boring: B-17

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                             | SOIL GRAPHIC                                                                      | SAMPLE TYPE                                                                       | DRILLING GRAPHIC                                                                  | DRILLING METHOD          | BLOW COUNTS<br>(N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL<br>Moisture Content                                                           | ATTERBERG<br>LIMITS              | NOTES/TESTING |
|----------------|------------|----------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------|--------------------------|---------------------------|----------|--------|---------|-------------------------------------------------------------------------------------|----------------------------------|---------------|
|                |            | ASPHALT, 4-inches 0.3                                    |  |  |  | 3 1/4" Hollow Stem Auger | 4-10-9<br>(19)           |                           | 2        | 66     | 32      |  | SC<br>LL: 37<br>PL: 22<br>PI: 15 |               |
|                |            | AGGREGATE ROAD BASE, 6-inches 0.8                        |  |  |  |                          | 3-2-3<br>(5)             |                           |          |        |         |                                                                                     |                                  |               |
|                |            | Medium dense to very loose,<br>moist, brown, CLAYEY SAND |  |  |  |                          | 2-1-2<br>(3)             |                           |          |        |         |                                                                                     |                                  |               |
|                | 5          |                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                          |                           |          |        |         |                                                                                     |                                  |               |
|                | 6.5        |                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                          |                           |          |        |         |                                                                                     |                                  |               |

End of boring at 6.5'

Remarks:

Date Begun: 08/29/2025  
Date Completed: 08/29/2025  
Termination Depth: 6.5'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)

None



End of Drilling (EOD)

None

Depth To Cave In: 5'



Location New Pavement Areas  
Boring Location 44.282021, -105.486252

## Soil Boring: B-18

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS         | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL<br>Moisture Content | ATTERBERG LIMITS              | NOTES/TESTING |
|----------------|------------|--------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|---------------------------|-------------------------------|---------------|
|                |            | ASPHALT, 4-inches 0.3                |              |             |                  |                 | 8-17-26 (43)          |                           |          |        |         |                           |                               |               |
|                |            | AGGREGATE ROAD BASE, 6-inches 0.8    |              |             |                  |                 | 17-30-34 (64)         |                           |          |        |         |                           |                               |               |
|                |            | Very dense, moist, brown, SILTY SAND |              |             |                  |                 | 16-28-45 (73)         |                           | 0        | 84     | 16      |                           |                               |               |
|                | 5          |                                      |              |             |                  |                 |                       |                           |          |        |         |                           |                               |               |
|                | 6.5        | End of boring at 6.5'                |              |             |                  |                 |                       |                           |          |        |         |                           | SM<br>LL: 0<br>PL: 0<br>PI: 0 |               |

Remarks:

Date Begun: 08/29/2025  
Date Completed: 08/29/2025  
Termination Depth: 6.5'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD)

None



End of Drilling (EOD)

None

Depth To Cave In: 5'



Location New Pavement Areas  
Boring Location 44.282039, -105.485520

## Soil Boring: B-19

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS     | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD          | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL<br>Moisture Content | ATTERBERG LIMITS | NOTES/TESTING |
|----------------|------------|----------------------------------|--------------|-------------|------------------|--------------------------|-----------------------|---------------------------|----------|--------|---------|---------------------------|------------------|---------------|
|                |            | TOPSOIL, 12-inches 1.0           |              |             |                  | 3 1/4" Hollow Stem Auger | 1-2-3 (5)             |                           |          |        |         |                           |                  |               |
|                |            | Loose, moist, brown, CLAYEY SAND |              |             |                  |                          | 3-3-4 (7)             |                           |          |        |         |                           |                  |               |
|                | 5          | Grades light brown               |              |             |                  |                          | 2-2-2 (4)             |                           |          |        |         |                           |                  |               |
|                | 6.5        |                                  |              |             |                  |                          |                       |                           |          |        |         |                           |                  |               |

End of boring at 6.5'

Remarks:

Date Begun: 08/27/2025  
Date Completed: 08/27/2025  
Termination Depth: 6.5'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

SPT - Standard Penetration Test

### WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) None

End of Drilling (EOD) None

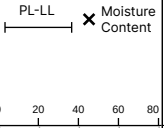
Depth To Cave In: 5'



Location New Pavement Areas  
Boring Location 44.281111, -105.486667

## Soil Boring: B-20

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                 | SOIL GRAPHIC                                                                      | SAMPLE TYPE                                                                       | DRILLING GRAPHIC                                                                  | DRILLING METHOD          | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS | NOTES/TESTING |
|----------------|------------|----------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------|-----------------------|---------------------------|----------|--------|---------|------------------------------------------------------------------------------------------------------------|------------------|---------------|
|                |            | TOPSOIL, 6-inches (Practice Field) 0.5       |  |  |  | 3 1/4" Hollow Stem Auger | 4-13-13 (26)          |                           |          |        |         |                                                                                                            |                  |               |
|                |            | Very stiff to soft, moist, brown, SANDY CLAY |  |  |  |                          | 2-2-4 (6)             | 0                         | 49       | 51     |         |                                                                                                            |                  |               |
|                | 5          | Grades firm, gray                            |  |  |  |                          | 4-3-10 (13)           |                           |          |        |         |                                                                                                            |                  |               |
|                | 6.5        |                                              |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                  |               |

End of boring at 6.5'

Remarks:

Date Begun: 08/29/2025  
Date Completed: 08/29/2025  
Termination Depth: 6.5'  
Crew: DAW, DAP, RTH  
Rig: #203 - CME-45 Diesel  
Drilling Method(s): 3 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES



SPT - Standard Penetration Test

### WATER LEVEL OBSERVATIONS



At Time of Drilling (ATD) None



End of Drilling (EOD) None

Depth To Cave In: 5'





Location Additional Exploration Area  
Boring Location 44.280366, -105.486545

## Soil Boring: B-22

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                       | SOIL GRAPHIC                                                                      | SAMPLE TYPE                                                                       | DILLING GRAPHIC                                                                   | DILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS                 | NOTES/TESTING |
|----------------|------------|--------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------|-----------------------|---------------------------|----------|--------|---------|------------------------------------------------------------------------------------------------------------|----------------------------------|---------------|
|                |            | TOPSOIL 0.5                                                        |  |  |  |                | 1-5-6 (11)            |                           |          |        |         |  19.3                   |                                  |               |
|                |            | Firm to hard, dry to moist, brown, fine grained, SANDY CLAY        |  |  |  |                | 7-10-17 (27)          |                           |          |        |         |  17.3                   |                                  |               |
|                | 5          |                                                                    |  |  |  |                | 9-8-34 (42)           | 0                         | 19       | 81     |         |  18.9                   | CL<br>LL: 35<br>PL: 20<br>PI: 15 |               |
|                |            |                                                                    |  |  |  |                | 22-50/6"              |                           |          |        |         |  14.6                   |                                  |               |
|                | 9.0        |                                                                    |  |  |  |                | 17-30-42 (72)         |                           |          |        |         |  14.5                   |                                  |               |
|                | 10         | Very dense, moist, tan to gray, fine to coarse grained, SILTY SAND |  |  |  |                | 21-35-50/5"           | 0                         | 82       | 18     |         |  9.9                    | SM<br>LL: 0<br>PL: 0<br>PI: 0    |               |
|                | 15         |                                                                    |  |  |  |                | 21-37-48 (85)         |                           |          |        |         |  9.1                    |                                  |               |
|                | 20         |                                                                    |  |  |  |                |                       |                           |          |        |         |                                                                                                            |                                  |               |
|                | 21.5       |                                                                    |  |  |  |                |                       |                           |          |        |         |                                                                                                            |                                  |               |

End of Boring @ 21.5'

Remarks:

Date Begun: 10/28/2025  
Date Completed: 10/28/2025  
Termination Depth: 21.5'  
Crew: SP, DL, IS  
Rig: #215 - CME-85 White  
Drilling Method(s): 4 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

 SPT - Standard Penetration Test

 DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) Dry

 End of Drilling (EOD) Dry

Depth To Cave In: 13.5'



Location Additional Exploration Area  
Boring Location 44.280256, -105.487686

# Soil Boring: B-23

Project Campbell County High School Project No. 25054-LX Client Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                                        | SOIL GRAPHIC | SAMPLE TYPE | DRILLING GRAPHIC | DRILLING METHOD | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS              | NOTES/TESTING |
|----------------|------------|-------------------------------------------------------------------------------------|--------------|-------------|------------------|-----------------|-----------------------|---------------------------|----------|--------|---------|-------------------------|-------------------------------|---------------|
|                | 0.5        | TOPSOIL                                                                             |              |             |                  | 0-2-7 (9)       |                       |                           |          |        |         |                         |                               |               |
|                |            | Hard, dry to moist, brown, fine grained, SANDY SILT                                 |              |             |                  | 9-18-26 (44)    |                       | 0                         | 13       | 87     |         |                         | ML<br>LL: 0<br>PL: 0<br>PI: 0 |               |
|                | 6.0        | Dense to very dense, dry to moist, brown to tan, fine to medium grained, SILTY SAND |              |             |                  | 12-15-25 (40)   |                       |                           |          |        |         |                         |                               |               |
|                |            |                                                                                     |              |             |                  | 17-43           |                       |                           |          |        |         |                         |                               |               |
|                |            | grades more coarse grained                                                          |              |             |                  | 17-26-34 (60)   |                       | 0                         | 80       | 20     |         |                         | SM<br>LL: 0<br>PL: 0<br>PI: 0 |               |
|                |            |                                                                                     |              |             |                  | 13-31-42 (73)   |                       |                           |          |        |         |                         |                               |               |
|                |            | some carbonaceous material                                                          |              |             |                  | 14-33-46 (79)   |                       |                           |          |        |         |                         |                               |               |
|                | 21.5       |                                                                                     |              |             |                  |                 |                       |                           |          |        |         |                         |                               |               |

End of Boring @ 21.5'

Remarks:

Date Begun: 10/28/2025  
Date Completed: 10/28/2025  
Termination Depth: 21.5'  
Crew: SP, DL, IS  
Rig: #215 - CME-85 White  
Drilling Method(s): 4 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

## SAMPLE TYPES

- SPT - Standard Penetration Test  
 DM - Dames and Moore

## WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) Dry  
End of Drilling (EOD) Dry

Depth To Cave In: 14'





Location Additional Exploration Area  
Boring Location 44.280689, -105.487246

## Soil Boring: B-24

**Project** Campbell County High School **Project No.** 25054-LX **Client** Plan One

| ELEVATION (ft) | DEPTH (ft) | SOIL DESCRIPTION AND REMARKS                                             | SOIL GRAPHIC                                                                      | SAMPLE TYPE                                                                       | DRILLING GRAPHIC                                                                  | DRILLING METHOD          | BLOW COUNTS (N VALUE) | q <sub>u</sub> (PP) (tsf) | % GRAVEL | % SAND | % FINES | PL-LL  Moisture Content | ATTERBERG LIMITS              | NOTES/TESTING |
|----------------|------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------|-----------------------|---------------------------|----------|--------|---------|------------------------------------------------------------------------------------------------------------|-------------------------------|---------------|
|                |            | TOPSOIL 0.5                                                              |  |  |  |                          | 2-3-4 (7)             |                           |          |        |         |  12.9                   |                               |               |
|                |            | Soft, moist, brown, SANDY CLAY                                           |  |  |  |                          |                       |                           |          |        |         |                                                                                                            |                               |               |
|                | 2.0        |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                               |               |
|                |            | Medium dense to very dense, dry, tan, fine to medium grained, SILTY SAND |  |  |  |                          | 5-9-9 (18)            |                           |          |        |         |  12.4                   |                               |               |
|                |            |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                               |               |
|                | 5          |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          | 9-15-19 (34)          | 0                         | 71       | 29     |         |  12.7                   | SM<br>LL: 0<br>PL: 0<br>PI: 0 |               |
|                |            | grades more coarse grained                                               |  |  |  |                          | 18-35                 |                           |          |        |         |  10                     |                               |               |
|                |            |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                               |               |
|                | 10         |                                                                          |                                                                                   |                                                                                   |                                                                                   | 4 1/4" Hollow Stem Auger | 16-25-32 (57)         |                           |          |        |         |  8.4                  |                               |               |
|                |            |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                               |               |
|                | 15         |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          | 17-22-37 (59)         | 0                         | 83       | 17     |         |  8.7                  | SM<br>LL: 0<br>PL: 0<br>PI: 0 |               |
|                |            |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                               |               |
|                | 20         |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          | 15-30-36 (66)         |                           |          |        |         |  8.7                  |                               |               |
|                |            |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                               |               |
|                | 21.5       |                                                                          |                                                                                   |                                                                                   |                                                                                   |                          |                       |                           |          |        |         |                                                                                                            |                               |               |

End of Boring @ 21.5'

Remarks:

Date Begun: 10/28/2025  
Date Completed: 10/28/2025  
Termination Depth: 21.5'  
Crew: SP, DL, IS  
Rig: #215 - CME-85 White  
Drilling Method(s): 4 1/4" Hollow Stem Auger  
Benchmark: Top of Boring Elev. = Existing Grade

### SAMPLE TYPES

 SPT - Standard Penetration Test

 DM - Dames and Moore

### WATER LEVEL OBSERVATIONS

At Time of Drilling (ATD) Dry

 End of Drilling (EOD) Dry

Depth To Cave In: 13'

## Appendix B

---

## **LABORATORY TESTING** **PROGRAM**

Soil samples were transported to our laboratory where they were subject to further evaluation, which may include visual classification according to ASTM D2488 or other analysis to determine certain engineering properties. Tests were performed in accordance with the test methods listed below.

| <b>Laboratory Test</b>                           | <b>Test Method</b> |
|--------------------------------------------------|--------------------|
| Moisture Content                                 | ASTM D2216         |
| Liquid Limit, Plastic Limit and Plasticity Index | ASTM D4318         |
| Sieve Analysis                                   | ASTM C117          |
| Sieve Analysis with Hydrometer                   | ASTM D422          |
| Sieve Analysis (200 Sieve only)                  | ASTM D1140         |
| Water Soluble Sulfate                            | Comparative        |
| Unconfined Compressive Strength                  | ASTM D2166         |
| Moisture-Density Relationship (Standard Proctor) | ASTM D698          |
| Moisture-Density Relationship (Modified Proctor) | ASTM D1557         |
| California Bearing Ratio (CBR)                   | ASTM D1883         |
| Hydraulic Conductivity                           | ASTM D5084         |
| Minimum Resistivity                              | AASHTO T288        |
| pH                                               | AASHTO T288        |
| Tube Density                                     | ASTM D2937         |
| Direct Shear                                     | ASTM D3080         |
| Consolidation-Swell                              | ASTM D2435         |

Test results that are not displayed on the test boring logs are presented in Appendix B of this report.

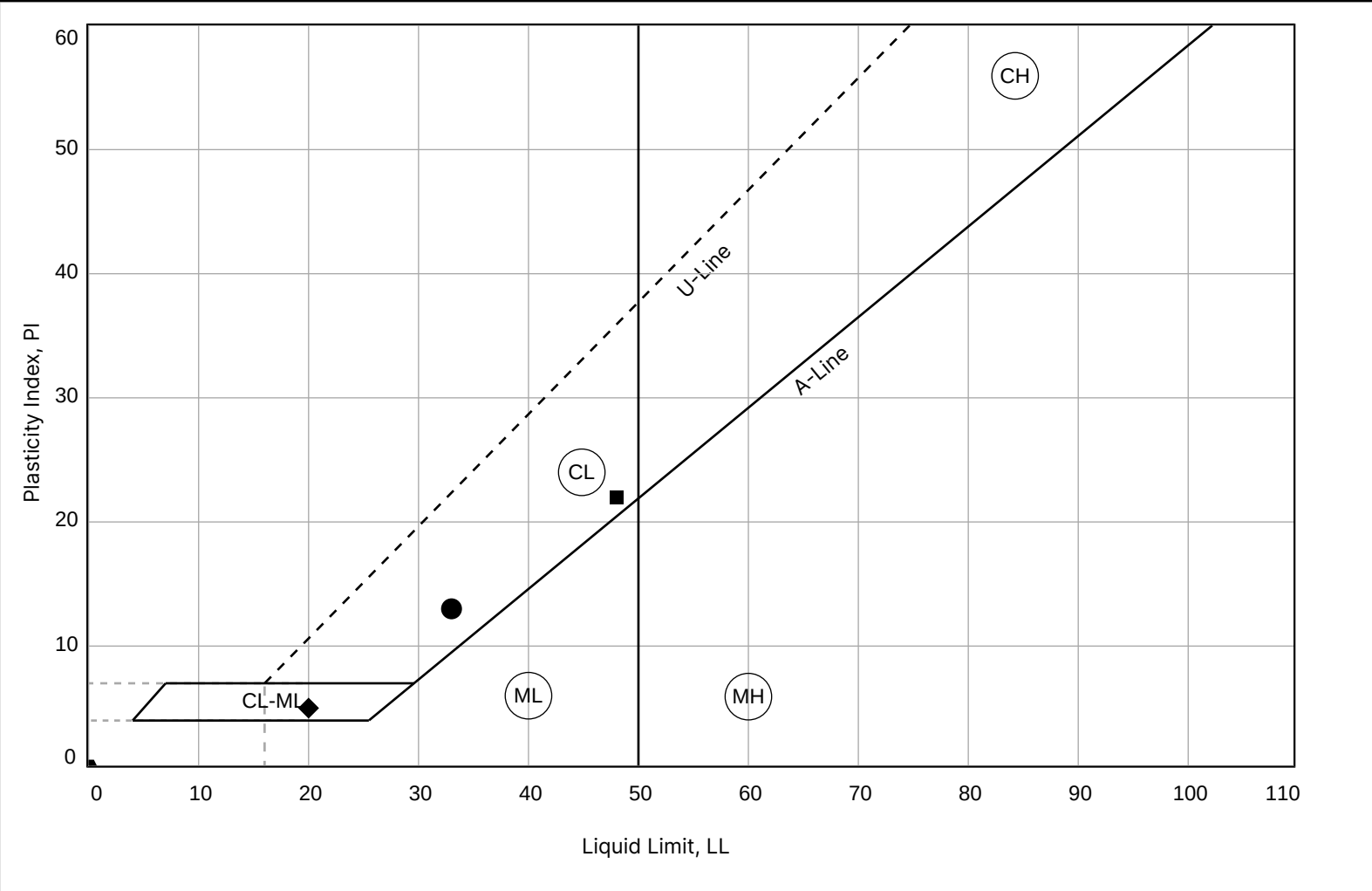
## Appendix C



ATTERBERG LIMITS TEST RESULTS

PROJECT Campbell County High School  
LOCATION 44.171, -105.2915

PROJECT NO. 25054-LX  
CLIENT Plan One



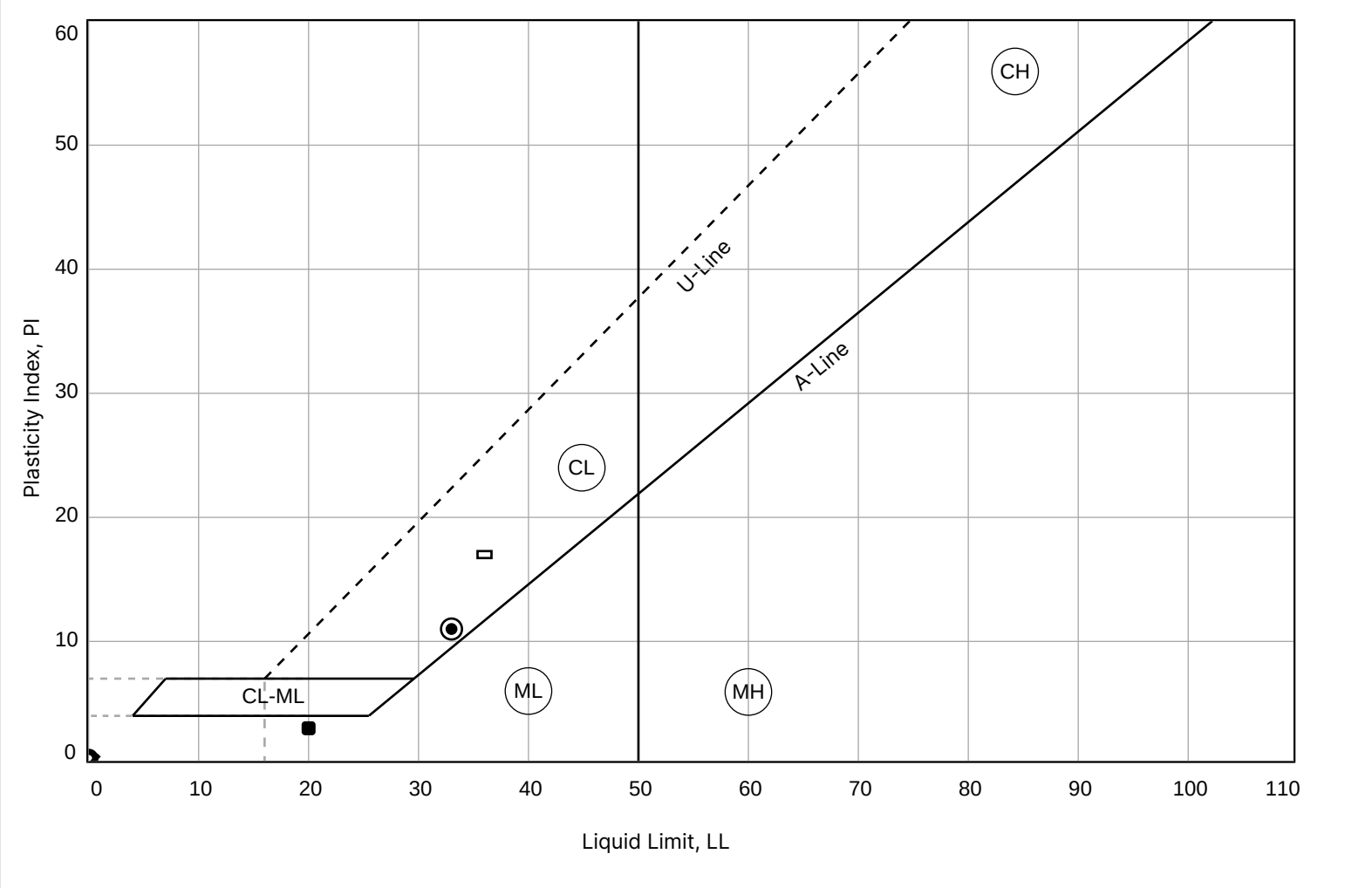
| ICON | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH (Feet) | USCS GROUP NAME    | USCS SYMBOL | LL | PL | PI | FINES (%) | NAT MC (%) | TEST STD     | TEST NOTE |
|------|--------------------|---------------|--------------|--------------------|-------------|----|----|----|-----------|------------|--------------|-----------|
| ■    | B-1                | 3             | 5            | CLAYEY SAND        | SC          | 48 | 26 | 22 | 48.61     | 17.2       | D4318 - 17e1 |           |
| ◆    | B-1                | 7             | 20           | SILTY, CLAYEY SAND | SC-SM       | 20 | 15 | 5  | 20.85     | 19.9       | D4318 - 17e1 |           |
| ▲    | B-2                | 4             | 7.5          | SILT with Sand     | ML          | 0  | 0  | 0  | 72.51     | 20.8       | D4318 - 17e1 |           |
| ●    | B-2                | 6             | 15           | SANDY SILT         | ML          | 0  | 0  | 0  | 54.92     | 22.9       | D4318 - 17e1 |           |
| ●    | B-3                | 5             | 10           | SANDY LEAN CLAY    | CL          | 33 | 20 | 13 | 53.32     | 21.3       | D4318 - 17e1 |           |



ATTERBERG LIMITS TEST RESULTS

PROJECT Campbell County High School  
LOCATION 44.171, -105.2915

PROJECT NO. 25054-LX  
CLIENT Plan One



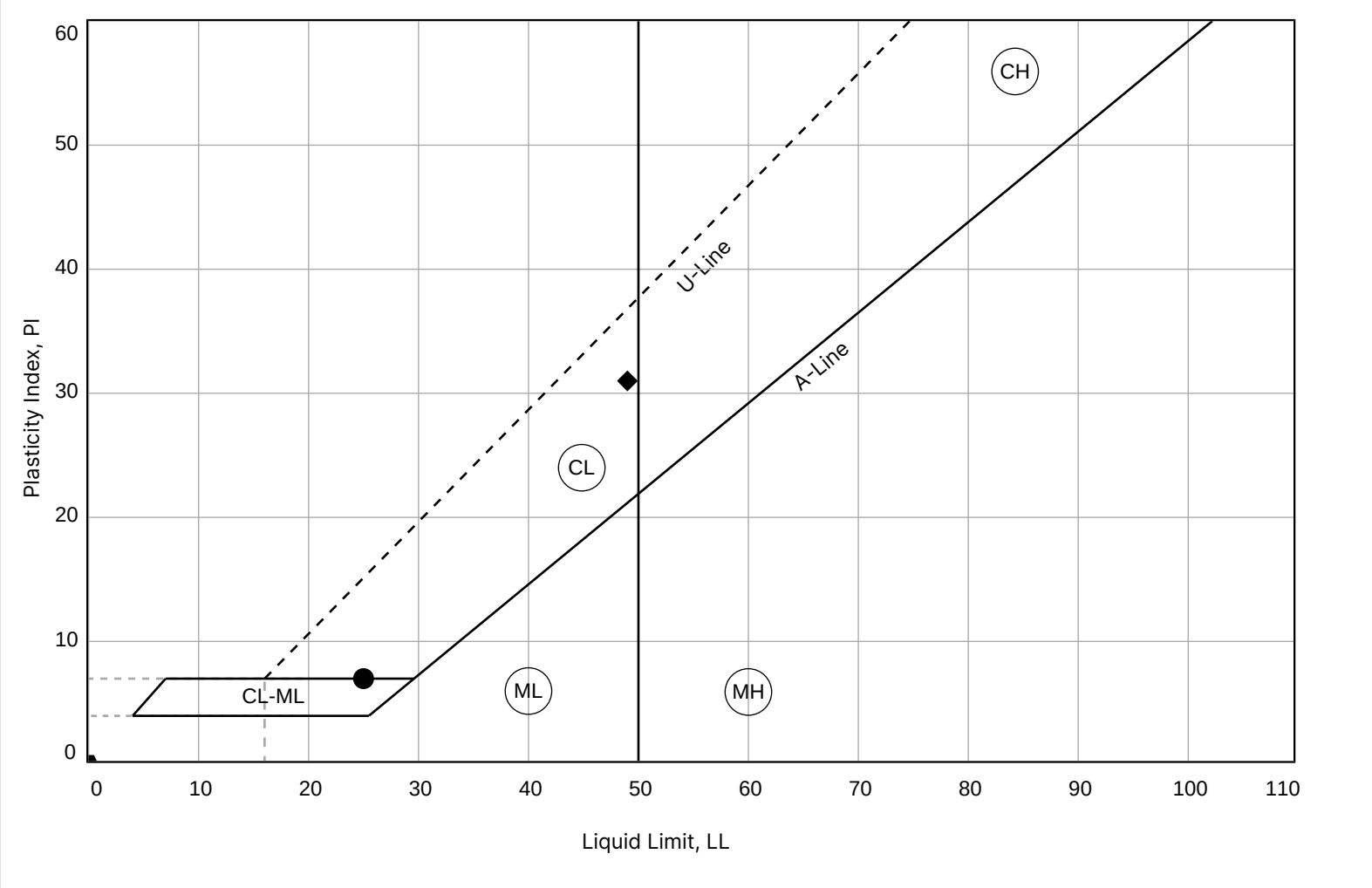
| ICON | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH (Feet) | USCS GROUP NAME | USCS SYMBOL | LL | PL | PI | FINES (%) | NAT MC (%) | TEST STD     | TEST NOTE |
|------|--------------------|---------------|--------------|-----------------|-------------|----|----|----|-----------|------------|--------------|-----------|
| ■    | B-4                | 3             | 5            | SILTY SAND      | SM          | 20 | 17 | 3  | 32.40     | 12.6       | D4318 - 17e1 |           |
| 📍    | B-4                | 6             | 15           | SANDY SILT      | ML          | 0  | 0  | 0  | 56.50     | 22.4       | D4318 - 17e1 |           |
| ▢    | B-5                | 4             | 7.5          | CLAYEY SAND     | SC          | 36 | 19 | 17 | 14.32     | 17.4       | D4318 - 17e1 |           |
| 🎯    | B-5                | 6             | 15           | CLAYEY SAND     | SC          | 33 | 22 | 11 | 47.54     | 23.3       | D4318 - 17e1 |           |
| ✖    | B-6                | 5             | 10           | SILTY SAND      | SM          | 0  | 0  | 0  | 12.56     | 15.7       | D4318 - 17e1 |           |



ATTERBERG LIMITS TEST RESULTS

PROJECT Campbell County High School  
LOCATION 44.171, -105.2915

PROJECT NO. 25054-LX  
CLIENT Plan One



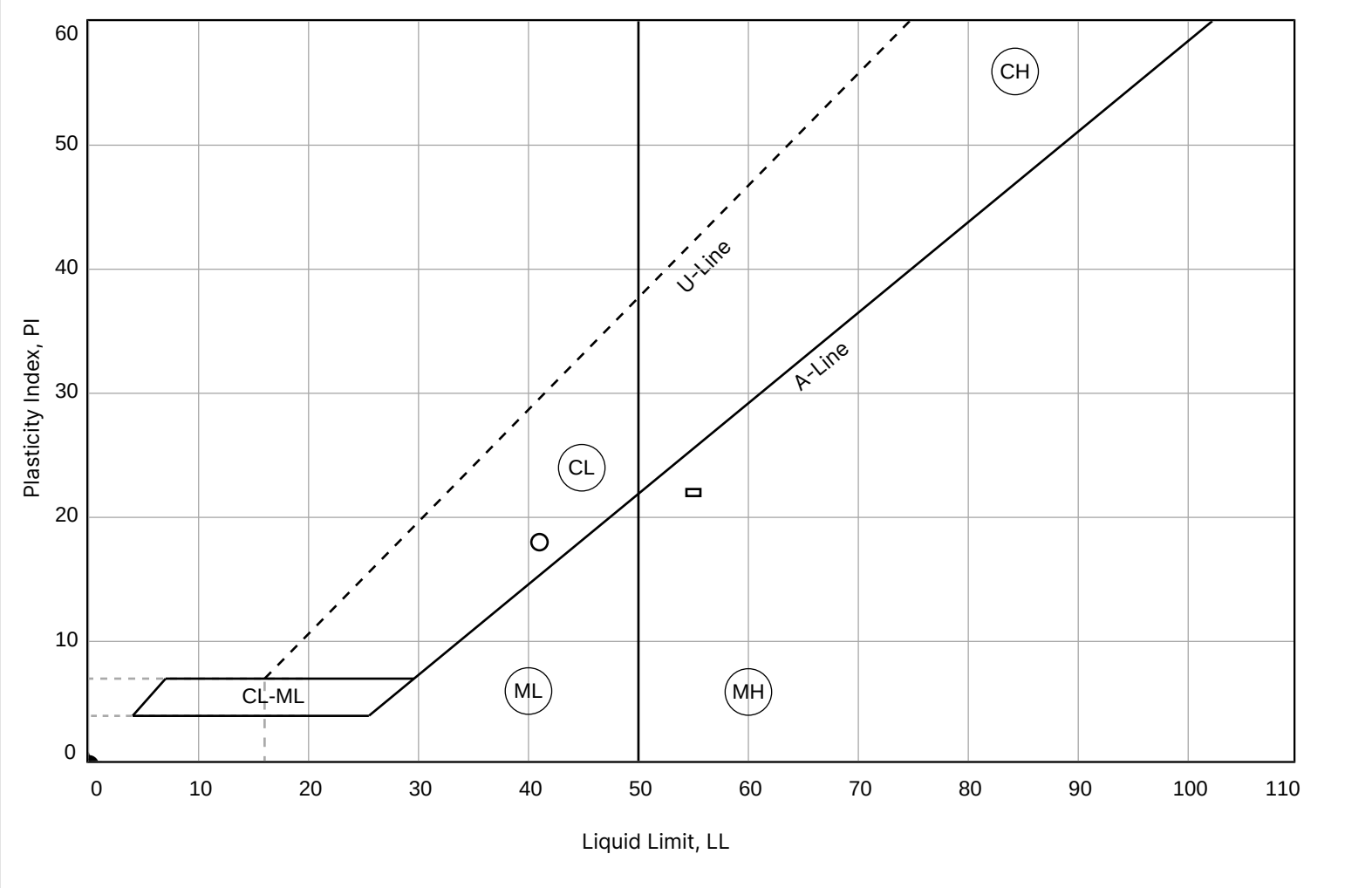
| ICON | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH (Feet) | USCS GROUP NAME    | USCS SYMBOL | LL | PL | PI | FINES (%) | NAT MC (%) | TEST STD     | TEST NOTE |
|------|--------------------|---------------|--------------|--------------------|-------------|----|----|----|-----------|------------|--------------|-----------|
| ■    | B-6                | 7             | 20           | SILTY SAND         | SM          | 0  | 0  | 0  | 14.31     | 24.1       | D4318 - 17e1 |           |
| ◆    | B-7                | 4             | 7.5          | SANDY LEAN CLAY    | CL          | 49 | 18 | 31 | 69.27     | 20.2       | D4318 - 17e1 |           |
| ▲    | B-7                | 7             | 20           | SANDY SILT         | ML          | 0  | 0  | 0  | 54.71     | 20.6       | D4318 - 17e1 |           |
| ●    | B-8                | 2             | 2.5          |                    |             | 0  | 0  | 0  | 11.32     | 8.3        | D4318 - 17e1 |           |
| ●    | B-8                | 6             | 15           | SILTY, CLAYEY SAND | SC-SM       | 25 | 18 | 7  | 14.79     | 21.3       | D4318 - 17e1 |           |



ATTERBERG LIMITS TEST RESULTS

PROJECT Campbell County High School  
LOCATION 44.171, -105.2915

PROJECT NO. 25054-LX  
CLIENT Plan One



| ICON | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH (Feet) | USCS GROUP NAME    | USCS SYMBOL | LL | PL | PI | FINES (%) | NAT MC (%) | TEST STD     | TEST NOTE |
|------|--------------------|---------------|--------------|--------------------|-------------|----|----|----|-----------|------------|--------------|-----------|
| ★    | B-9                | 6             | 15           | SILTY SAND         | SM          | 0  | 0  | 0  | 14.35     | 20.1       | D4318 - 17e1 |           |
| ○    | B-10               | 4             | 7.5          | CLAYEY SAND        | SC          | 41 | 23 | 18 | 34.88     | 14.4       | D4318 - 17e1 |           |
| ■    | B-10               | 8             | 25           | SILTY SAND         | SM          | 0  | 0  | 0  | 28.71     | 23.9       | D4318 - 17e1 |           |
| □    | B-11               | 5             | 10           | SANDY ELASTIC SILT | MH          | 55 | 33 | 22 | 65.84     | 19.7       | D4318 - 17e1 |           |
| ●    | B-12               | 4             | 7.5          | SILTY SAND         | SM          | 0  | 0  | 0  | 22.20     | 5.3        | D4318 - 17e1 |           |

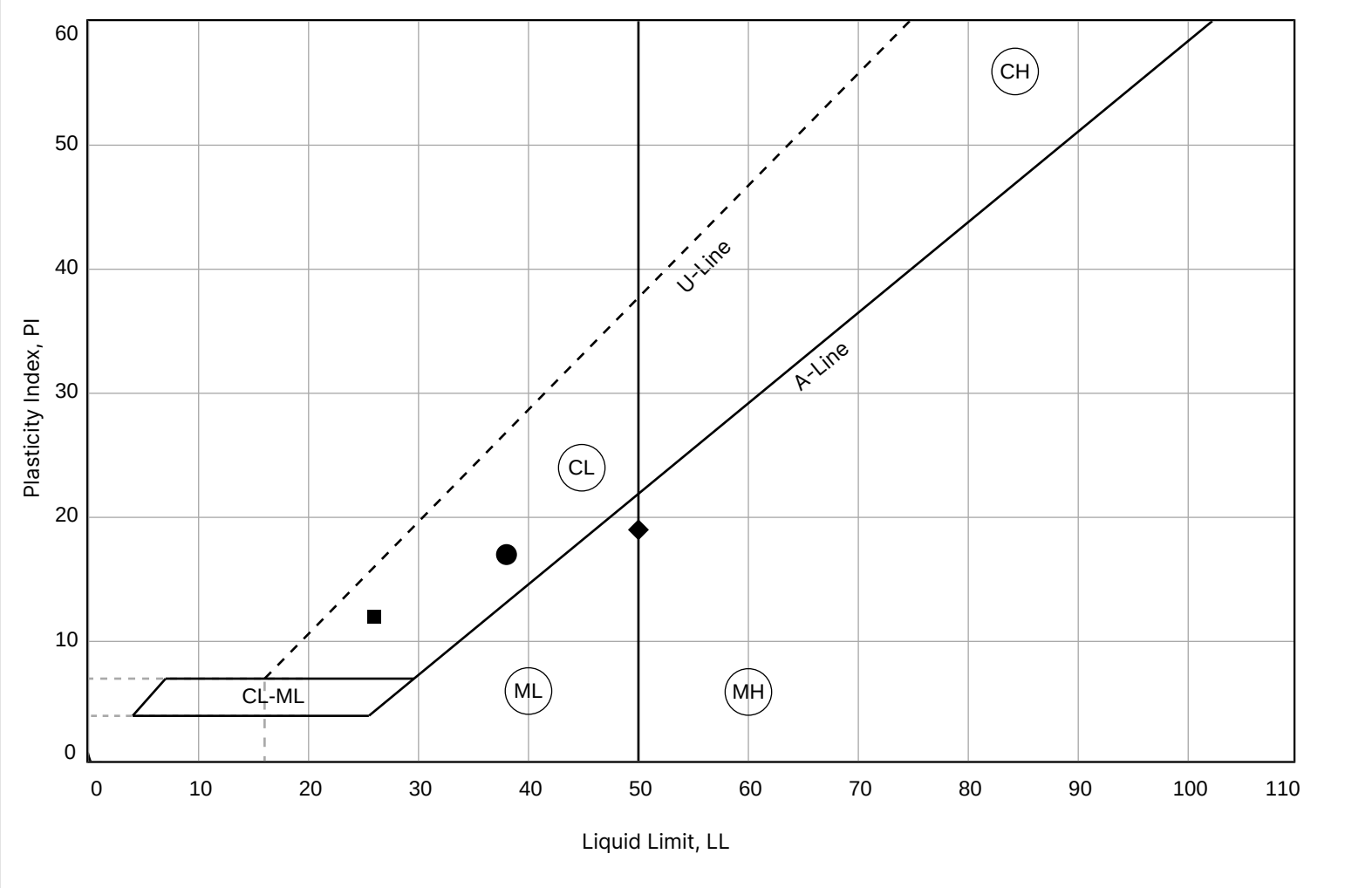




ATTERBERG LIMITS TEST RESULTS

PROJECT Campbell County High School  
LOCATION 44.171, -105.2915

PROJECT NO. 25054-LX  
CLIENT Plan One



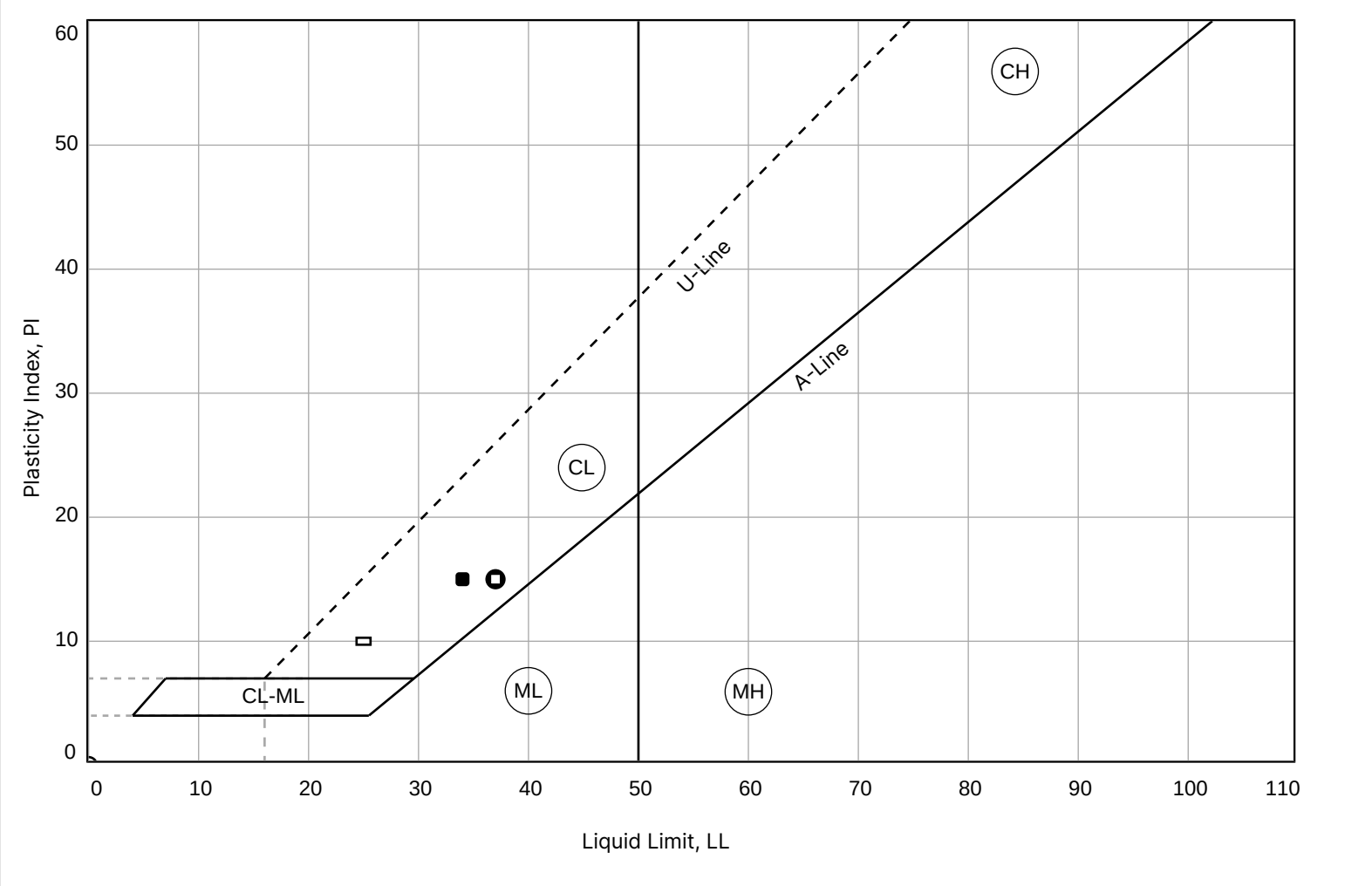
| ICON | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH (Feet) | USCS GROUP NAME     | USCS SYMBOL | LL | PL | PI | FINES (%) | NAT MC (%) | TEST STD     | TEST NOTE |
|------|--------------------|---------------|--------------|---------------------|-------------|----|----|----|-----------|------------|--------------|-----------|
| ■    | B-13               | 3             | 5            | CLAYEY SAND         | SC          | 26 | 14 | 12 | 23.81     | 11.9       | D4318 - 17e1 |           |
| ◆    | B-14               | 3             | 5            | SANDY ELASTIC SILT  | MH          | 50 | 31 | 19 | 63.19     | 21.4       | D4318 - 17e1 |           |
| ▲    | B-14               | 5             | 10           | SILTY SAND          | SM          | 0  | 0  | 0  | 15.74     | 24.0       | D4318 - 17e1 |           |
| ●    | B-15               | 2             | 2.5          | LEAN CLAY with Sand | CL          | 38 | 21 | 17 | 74.64     | 21.4       | D4318 - 17e1 |           |
| ★    | B-16               | 2             | 2.5          |                     |             | 0  | 0  | 0  | 11.44     | 8.3        | D4318 - 17e1 |           |



ATTERBERG LIMITS TEST RESULTS

PROJECT Campbell County High School  
LOCATION 44.171, -105.2915

PROJECT NO. 25054-LX  
CLIENT Plan One



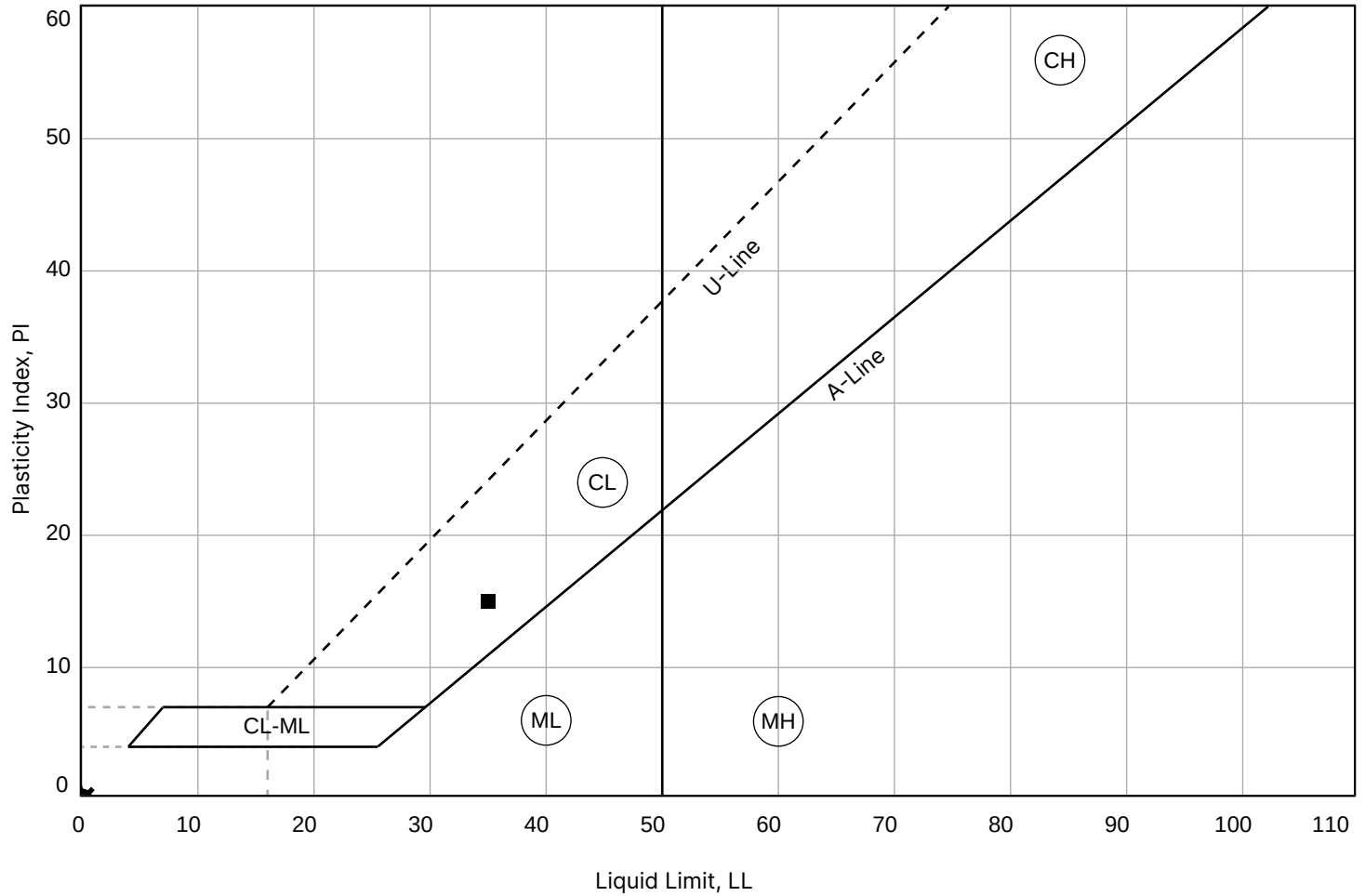
| ICON | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH (Feet) | USCS GROUP NAME | USCS SYMBOL | LL | PL | PI | FINES (%) | NAT MC (%) | TEST STD     | TEST NOTE |
|------|--------------------|---------------|--------------|-----------------|-------------|----|----|----|-----------|------------|--------------|-----------|
| ○    | B-17               | 1             | 0            | CLAYEY SAND     | SC          | 37 | 22 | 15 | 32.35     | 13.0       | D4318 - 17e1 |           |
| ○    | B-18               | 3             | 5            | SILTY SAND      | SM          | 0  | 0  | 0  | 16.40     | 9.3        | D4318 - 17e1 |           |
| ■    | B-20               | 2             | 2.5          | SANDY LEAN CLAY | CL          | 34 | 19 | 15 | 50.85     | 13.3       | D4318 - 17e1 |           |
| □    | B-21               | 3             | 5            | CLAYEY SAND     | SC          | 25 | 15 | 10 | 35.31     | 13.6       | D4318 - 17e1 |           |



# ATTERBERG LIMITS TEST RESULTS

**PROJECT** Campbell County High School  
**LOCATION** 44.171, -105.2915

**PROJECT NO.** 25054-LX  
**CLIENT** Plan One



| ICON | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH (Feet) | LL | PL | PI | FINES (%) | NAT MC (%) | TEST STD     |
|------|--------------------|---------------|--------------|----|----|----|-----------|------------|--------------|
| ■    | B-22               | B22 3         | 5            | 35 | 20 | 15 | 80.87     | 18.9       | D4318 - 17e1 |
| ✕    | B-22               | B22 6         | 15           | 0  | 0  | 0  | 17.75     | 9.9        | D4318 - 17e1 |
| ▲    | B-23               | B23 2         | 2.5          | 0  | 0  | 0  | 87.03     | 18.3       | D4318 - 17e1 |
| ●    | B-23               | B23 5         | 10           | 0  | 0  | 0  | 20.15     | 10.7       | D4318 - 17e1 |
| ★    | B-24               | B24 3         | 5            | 0  | 0  | 0  | 28.77     | 12.7       | D4318 - 17e1 |
| ○    | B-24               | B24 6         | 15           | 0  | 0  | 0  | 17.25     | 8.7        | D4318 - 17e1 |

# CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Campbell County High School

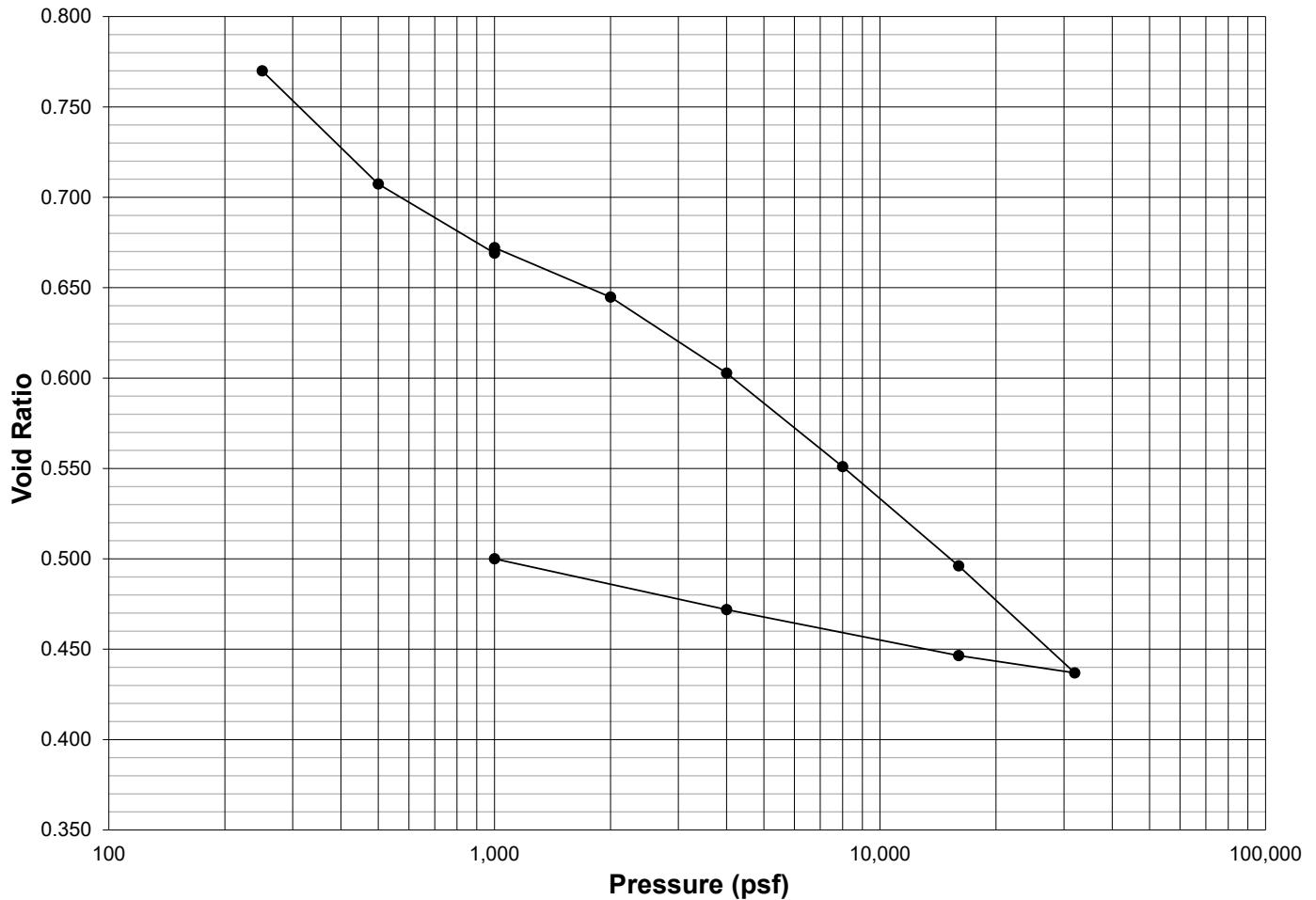
Client: Plan One Architects

Job No: 25054-LX

Test Date: 9/17/2025

Sample No: B-2

Depth (ft): 5



Soil Description: Gray SILT

Specimen Diameter: 2.416 in.

Specimen Height: 1.03 in.

Liquid Limit (%): NP

Overburden Pressure (Po): 596 psf

Plastic Limit (%): NP

Preconsolidation Pressure (Pp): 2800 psf

Plasticity Index (%): NP

Overconsolidation Ratio: (OCR = pp/po) 4.7

|                   | <u>Initial</u> | <u>Final</u> |
|-------------------|----------------|--------------|
| Moisture Content: | 21.6%          | 21.7%        |

Comp. Index (Cc): 0.189

Saturation: 76% 107%

Consol. Index (Cr): 0.044

Wet Density (pcf): 115.8 132.4

Dry Density (pcf): 95.2 108.8

Swell Pressure: 1200 psf

Percent Swell or Collapse\*: 0.18% (- indicates collapse) Pressure when wetted: 1000 psf

# CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Campbell County High School

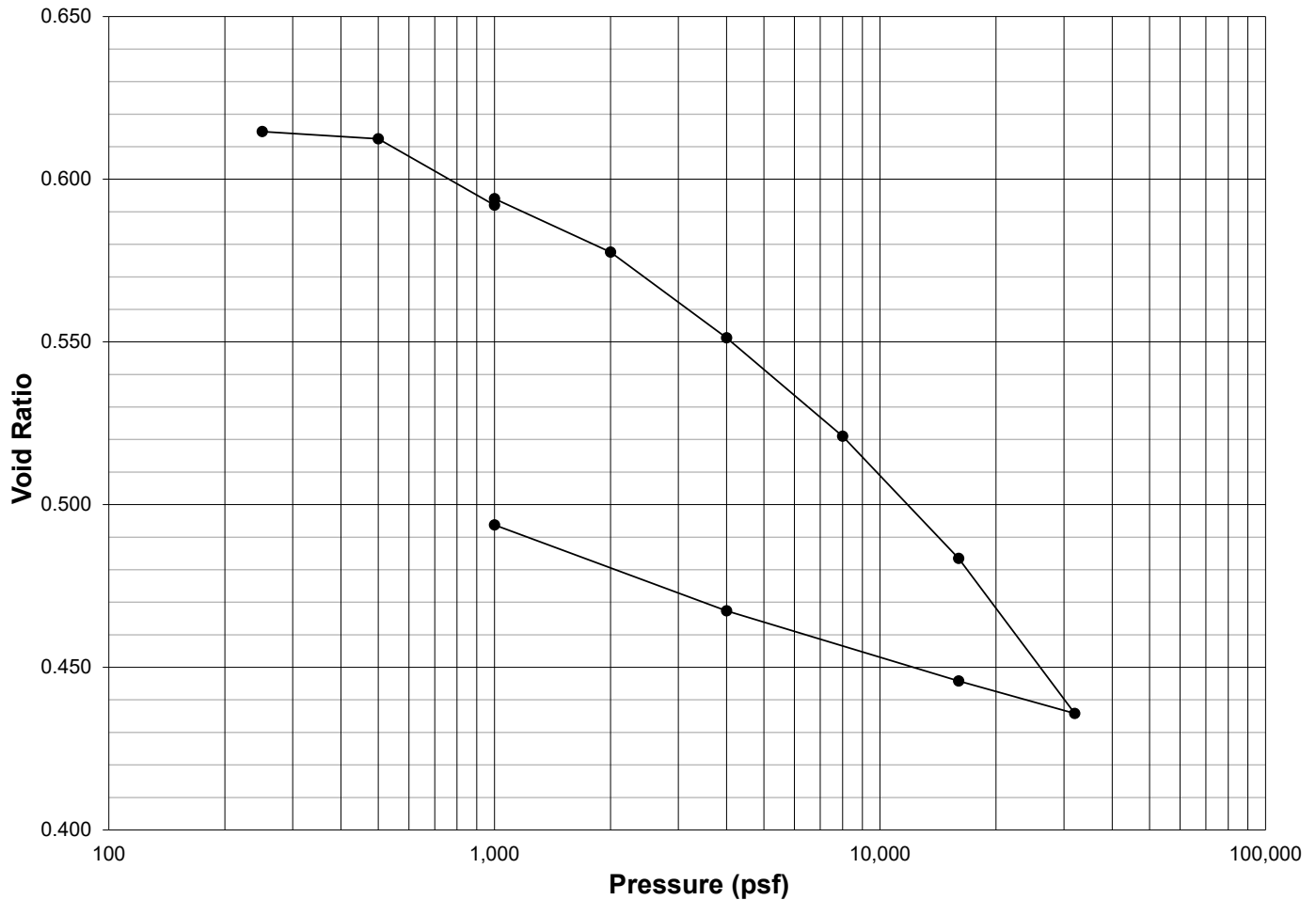
Client: Plan One Architects

Job No: 25054-LX

Test Date: 9/19/2025

Sample No: B-7

Depth (ft): 10



Soil Description: Gray CLAY

Specimen Diameter: 2.41 in.

Specimen Height: 1.00 in.

Liquid Limit (%): 49

Overburden Pressure (Po): 1252 psf

Plastic Limit (%): 18

Preconsolidation Pressure (Pp): 4000 psf

Plasticity Index (%): 31

Overconsolidation Ratio: (OCR = pp/po) 3.2

|                   | Initial | Final |
|-------------------|---------|-------|
| Moisture Content: | 20.0%   | 21.3% |

Comp. Index (Cc): 0.141

Saturation: 88% 78%

Consol. Index (Cr): 0.040

Wet Density (pcf): 125.2 117.4

Dry Density (pcf): 104.3 96.8

Swell Pressure: 1100 psf

Percent Swell or Collapse\*: 0.13% (- indicates collapse) Pressure when wetted: 1000 psf

# CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Campbell County High School

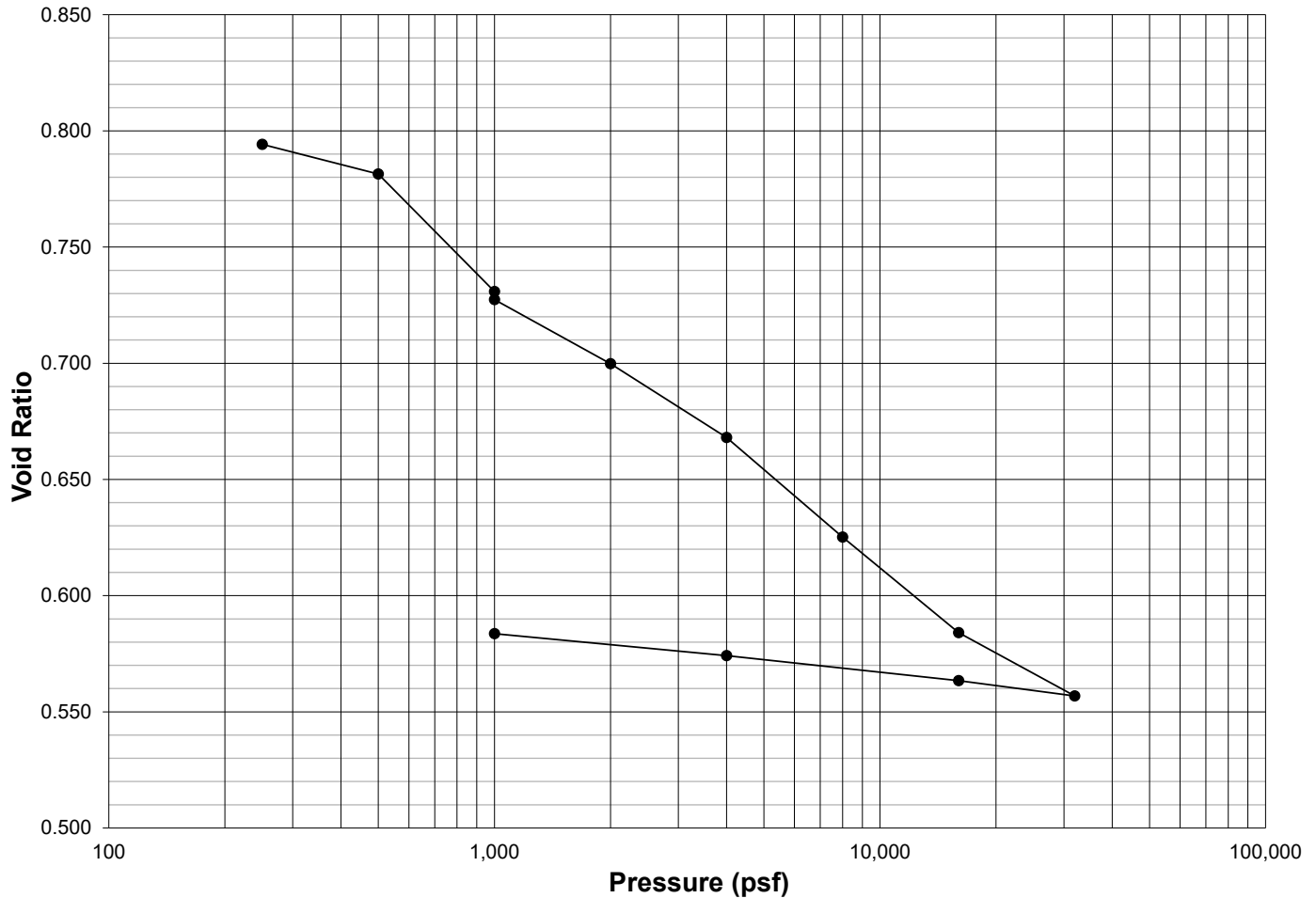
Client: Plan One Architects

Job No: 25054-LX

Test Date: 9/30/2025

Sample No: B-9

Depth (ft): 20



Soil Description: Light Brown SAND

Specimen Diameter: 2.415 in.

Specimen Height: 1.00 in.

Liquid Limit (%): NP

Overburden Pressure (Po): 2018 psf

Plastic Limit (%): NP

Preconsolidation Pressure (Pp): 2200 psf

Plasticity Index (%): NP

Overconsolidation Ratio: (OCR = pp/po) 1.1

|                   | Initial | Final |
|-------------------|---------|-------|
| Moisture Content: | 24.0%   | 29.0% |

Comp. Index (Cc): 0.113

Saturation: 82% 88%

Consol. Index (Cr): 0.017

Wet Density (pcf): 116.5 115.2

Dry Density (pcf): 93.9 89.3

Swell Pressure: psf

Percent Swell or Collapse\*: -0.20% (- indicates collapse) Pressure when wetted: 1000 psf

# CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Campbell County High School

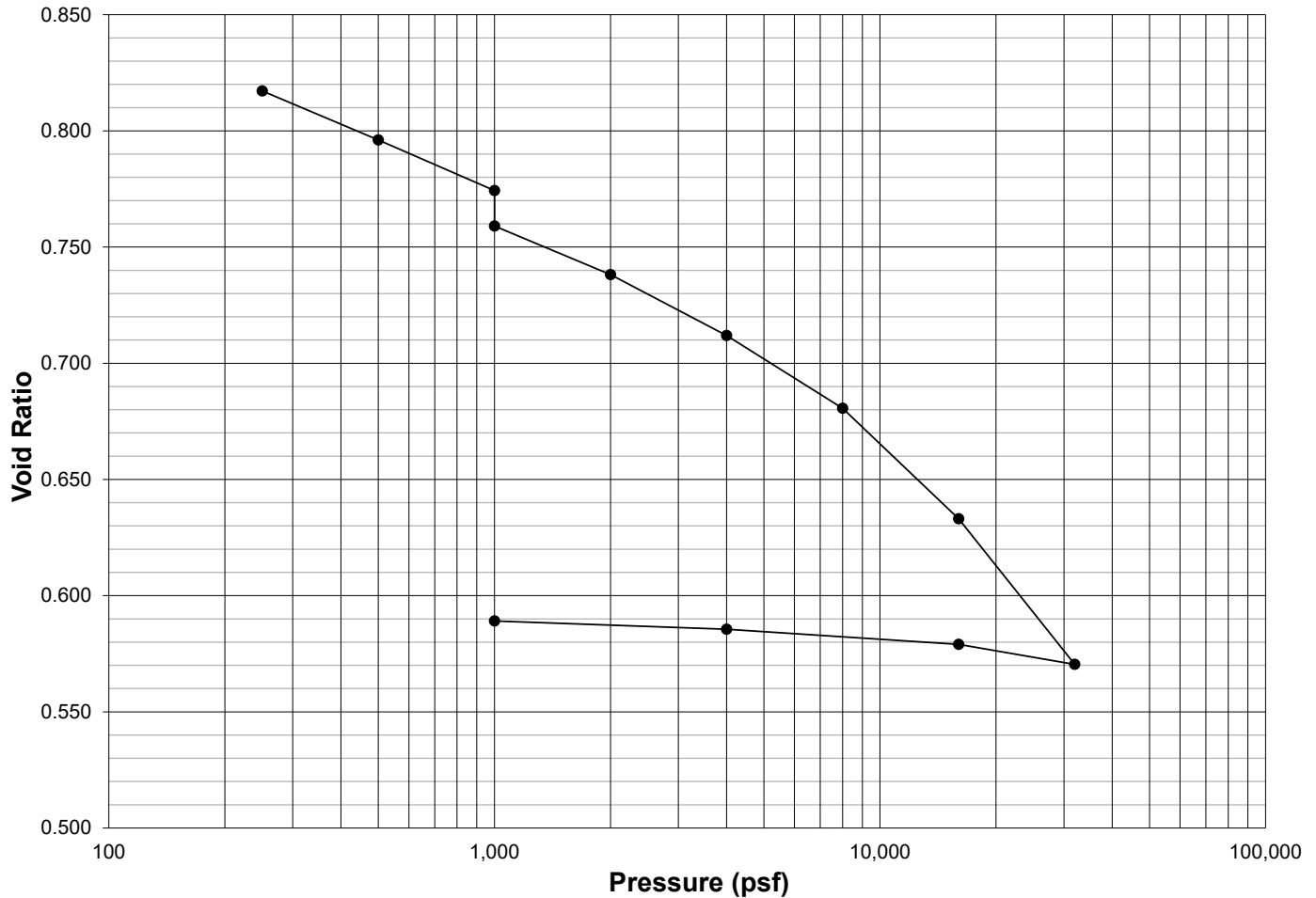
Client: Plan One Architects

Job No: 25054-LX

Test Date: 10/6/2025

Sample No: B-11

Depth (ft): 7.5



Soil Description: Gray SILT

Specimen Diameter: 2.4155 in.

Specimen Height: 1.00 in.

Liquid Limit (%): 55

Overburden Pressure ( $P_o$ ): 814 psf

Plastic Limit (%): 33

Preconsolidation Pressure ( $P_p$ ): 4000 psf

Plasticity Index (%): 22

Overconsolidation Ratio: ( $OCR = P_p/P_o$ ) 4.9

|                   | Initial | Final |
|-------------------|---------|-------|
| Moisture Content: | 17.1%   | 32.2% |

Comp. Index ( $C_c$ ): 0.183

Saturation: 56% 106%

Consol. Index ( $C_r$ ): 0.008

Wet Density (pcf): 108.5 122.3

Dry Density (pcf): 92.7 92.5

Swell Pressure: psf

Percent Swell or Collapse\*: -0.86% (- indicates collapse) Pressure when wetted: 1000 psf

# CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Campbell County High School

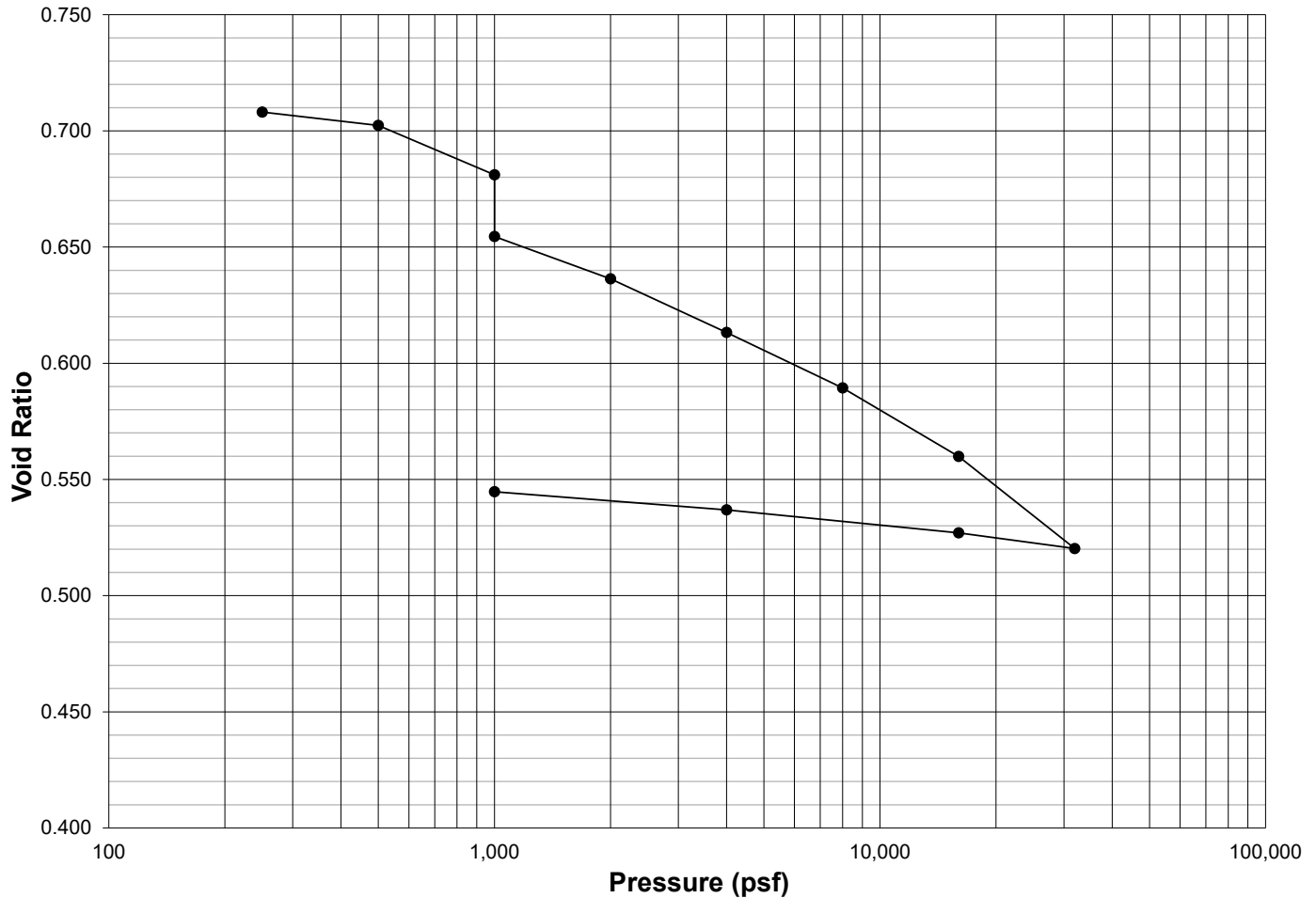
Client: Plan One Architects

Job No: 25054-LX

Test Date: 10/30/2025

Sample No: B-22

Depth (ft): 7.5



Soil Description: Gray Sandy Clay

Specimen Diameter: 2.42 in.

Specimen Height: 0.97 in.

Liquid Limit (%): 35

Overburden Pressure ( $P_o$ ): 851 psf

Plastic Limit (%): 20

Preconsolidation Pressure ( $P_p$ ): 4200 psf

Plasticity Index (%): 15

Overconsolidation Ratio: ( $OCR = P_p/P_o$ ) 4.9

|                   | <u>Initial</u> | <u>Final</u> |
|-------------------|----------------|--------------|
| Moisture Content: | 15.1%          | 30.1%        |

Comp. Index ( $C_c$ ): 0.115

Saturation: 57% 99%

Consol. Index ( $C_r$ ): 0.015

Wet Density (pcf): 113.5 120.5

Dry Density (pcf): 98.6 92.6

Swell Pressure: psf

Percent Swell or Collapse\*: -1.58% (- indicates collapse) Pressure when wetted: 1000 psf



# CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Campbell County High School

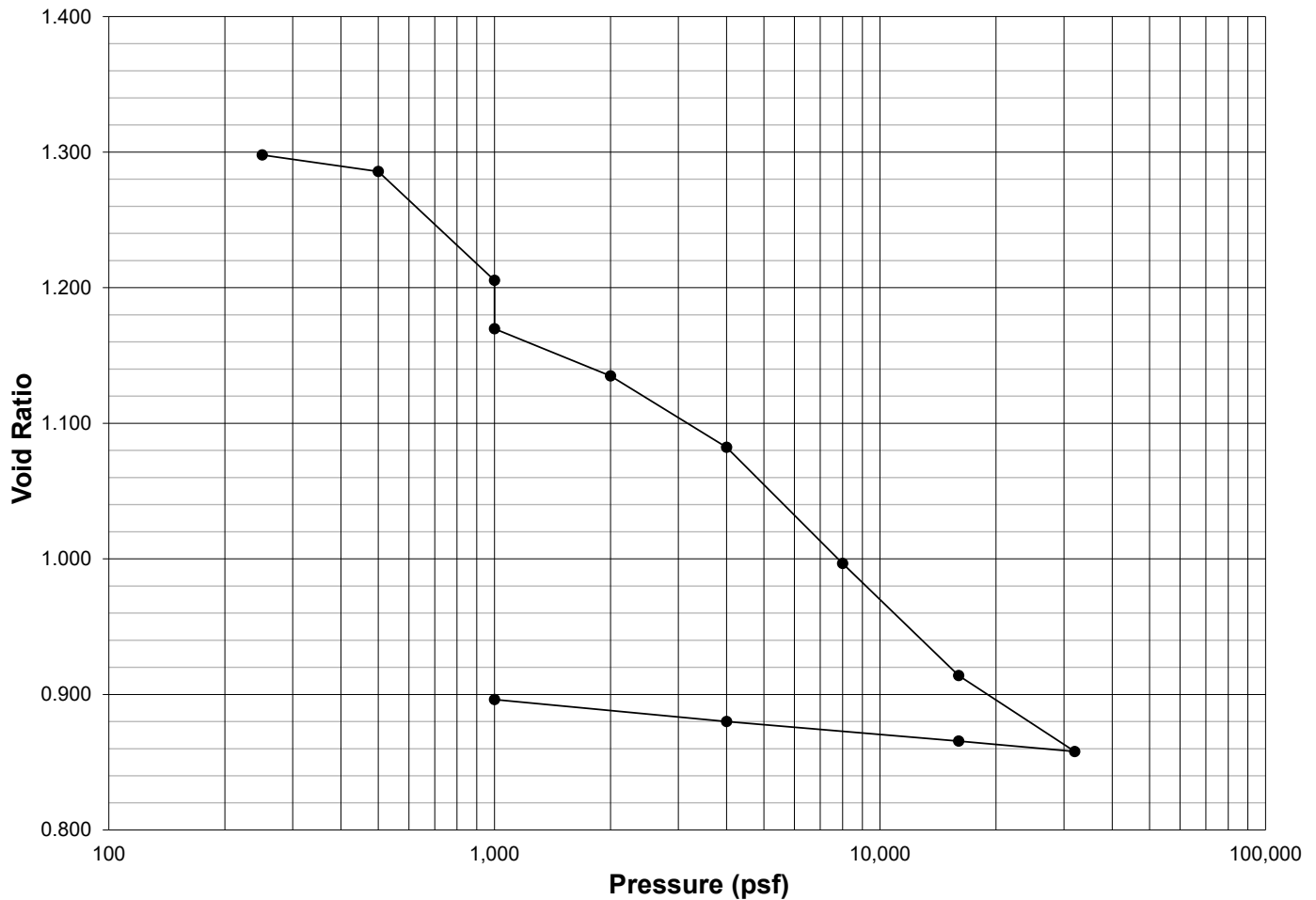
Client: Plan One Architects

Job No: 25054-LX

Test Date: 11/3/2025

Sample No: B-23

Depth (ft): 7.5



Soil Description: Lt. Brown Sand

Specimen Diameter: 2.42 in.

Specimen Height: 0.97 in.

Liquid Limit (%): NP

Overburden Pressure ( $P_o$ ): 725 psf

Plastic Limit (%): NP

Preconsolidation Pressure ( $P_p$ ): 2500 psf

Plasticity Index (%): NP

Overconsolidation Ratio: ( $OCR = P_p/P_o$ ) 3.4

|                   | <u>Initial</u> | <u>Final</u> |
|-------------------|----------------|--------------|
| Moisture Content: | 31.8%          | 29.0%        |

Comp. Index ( $C_c$ ): 0.230

Saturation: 66% 72%

Consol. Index ( $C_r$ ): 0.025

Wet Density (pcf): 96.6 103.8

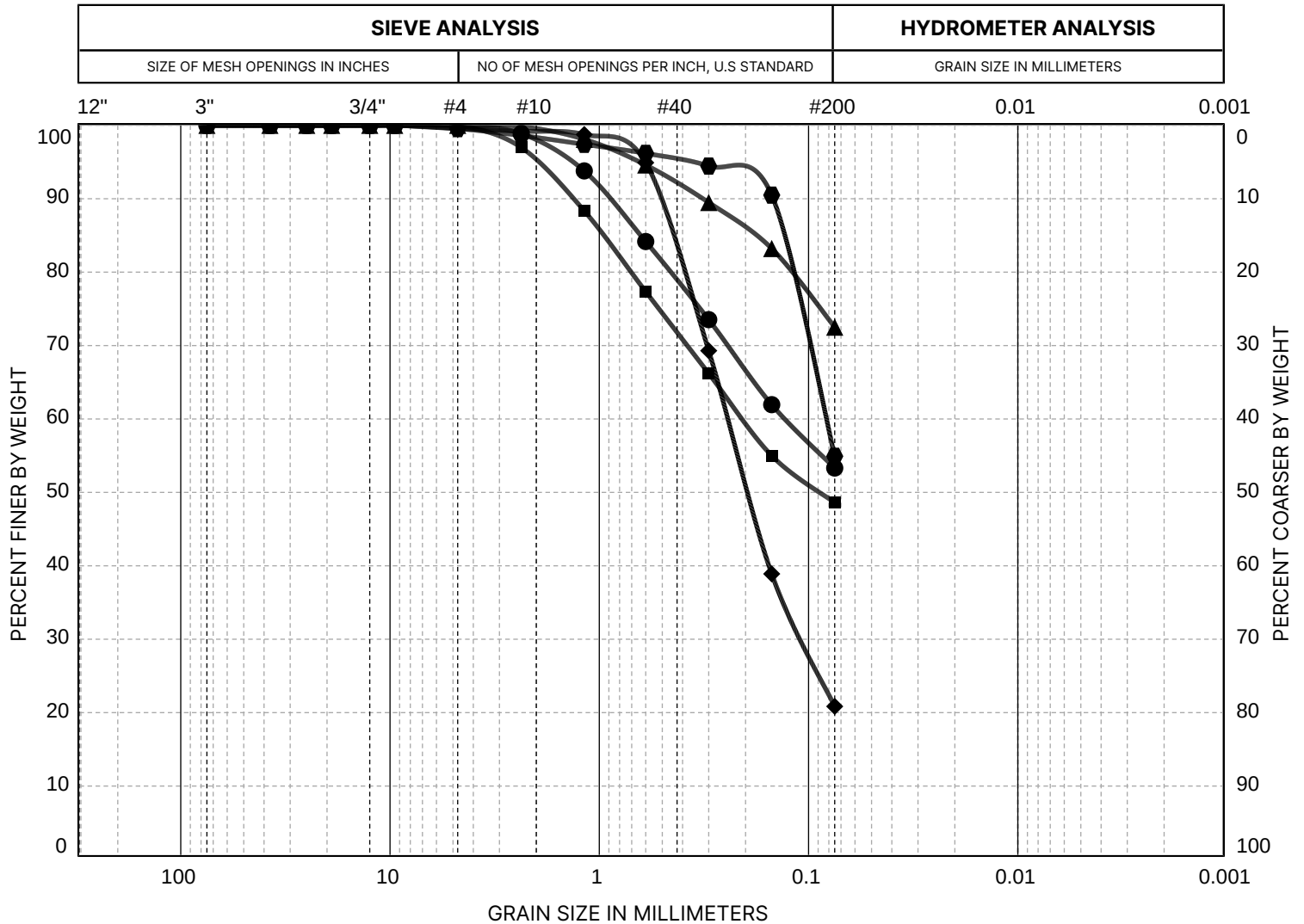
Dry Density (pcf): 73.3 80.5

Swell Pressure: psf

Percent Swell or Collapse\*: -1.62% (- indicates collapse) Pressure when wetted: 1000 psf



Campbell County High School  
44.171, -105.2915

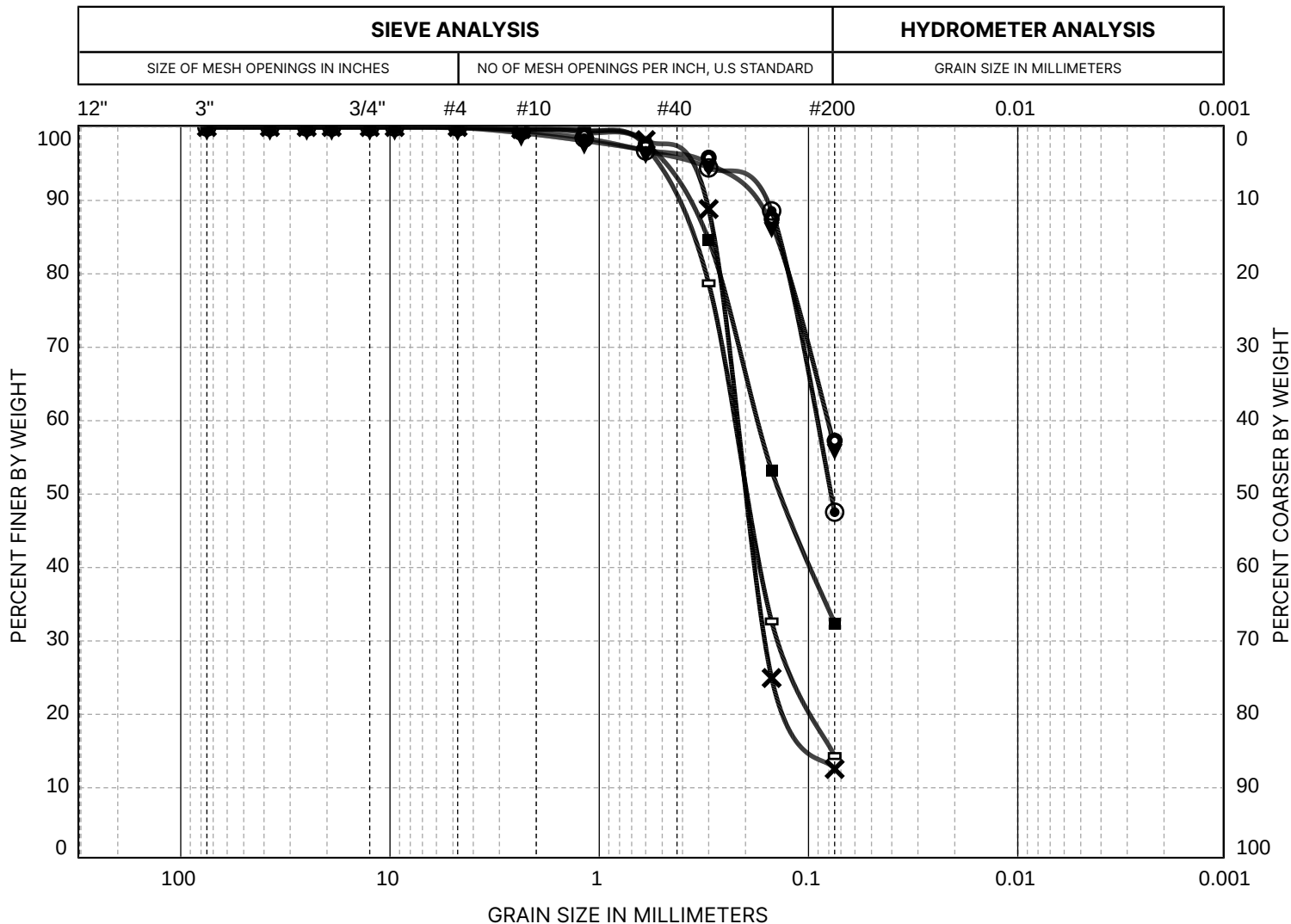


| COBBLES | GRAVEL |      | SAND   |        |      | FINES: SILT OR CLAY |
|---------|--------|------|--------|--------|------|---------------------|
|         | COARSE | FINE | COARSE | MEDIUM | FINE |                     |

|   | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH | GRAVEL (%) | SAND (%) | FINES (%) | D10 | D30  | D60  | D100  | CU | CC |
|---|--------------------|---------------|-------|------------|----------|-----------|-----|------|------|-------|----|----|
| ■ | B-1                | 3             | 5     | 0.00       | 51.39    | 48.61     |     |      | 0.21 | 13.29 |    |    |
| ◆ | B-1                | 7             | 20    | 0.45       | 78.70    | 20.85     |     | 0.11 | 0.24 | 13.29 |    |    |
| ▲ | B-2                | 4             | 7.5   | 0.00       | 27.49    | 72.51     |     |      |      | 13.29 |    |    |
| ⬠ | B-2                | 6             | 15    | 0.45       | 44.63    | 54.92     |     |      | 0.08 | 13.29 |    |    |
| ● | B-3                | 5             | 10    | 0.04       | 46.65    | 53.32     |     |      | 0.13 | 13.29 |    |    |



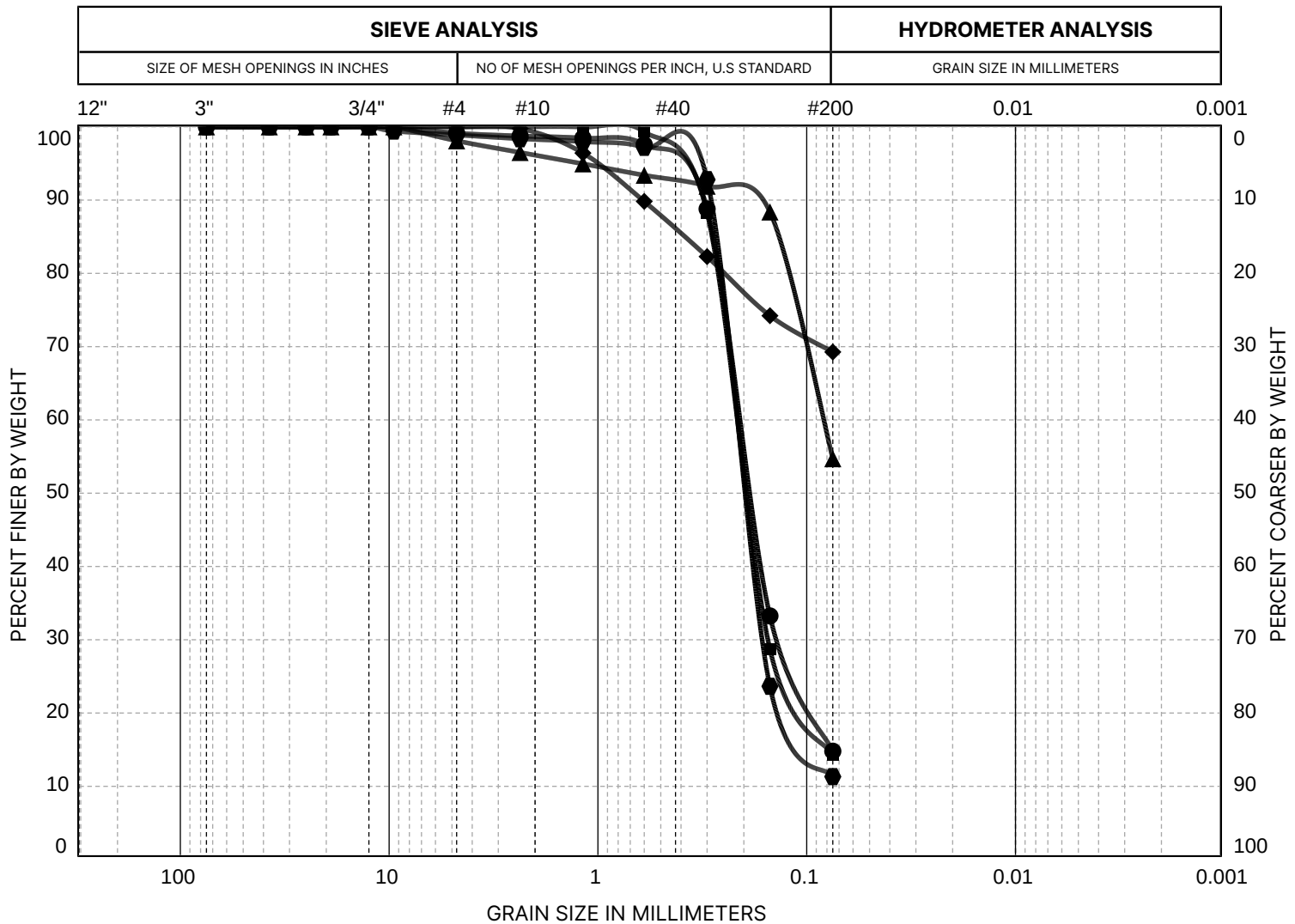
Campbell County High School  
44.171, -105.2915



|   | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH | GRAVEL (%) | SAND (%) | FINES (%) | D10 | D30  | D60  | D100  | CU | CC |
|---|--------------------|---------------|-------|------------|----------|-----------|-----|------|------|-------|----|----|
| □ | B-5                | 4             | 7.5   | 0.12       | 85.56    | 14.32     |     | 0.14 | 0.22 | 13.29 |    |    |
| × | B-6                | 5             | 10    | 0.00       | 87.44    | 12.56     |     | 0.16 | 0.22 | 13.29 |    |    |
| ■ | B-4                | 3             | 5     | 0.00       | 67.60    | 32.40     |     |      | 0.18 | 13.29 |    |    |
| ● | B-4                | 6             | 15    | 0.09       | 43.41    | 56.50     |     |      | 0.08 | 13.29 |    |    |
| ⊙ | B-5                | 6             | 15    | 0.00       | 52.46    | 47.54     |     |      | 0.09 | 13.29 |    |    |



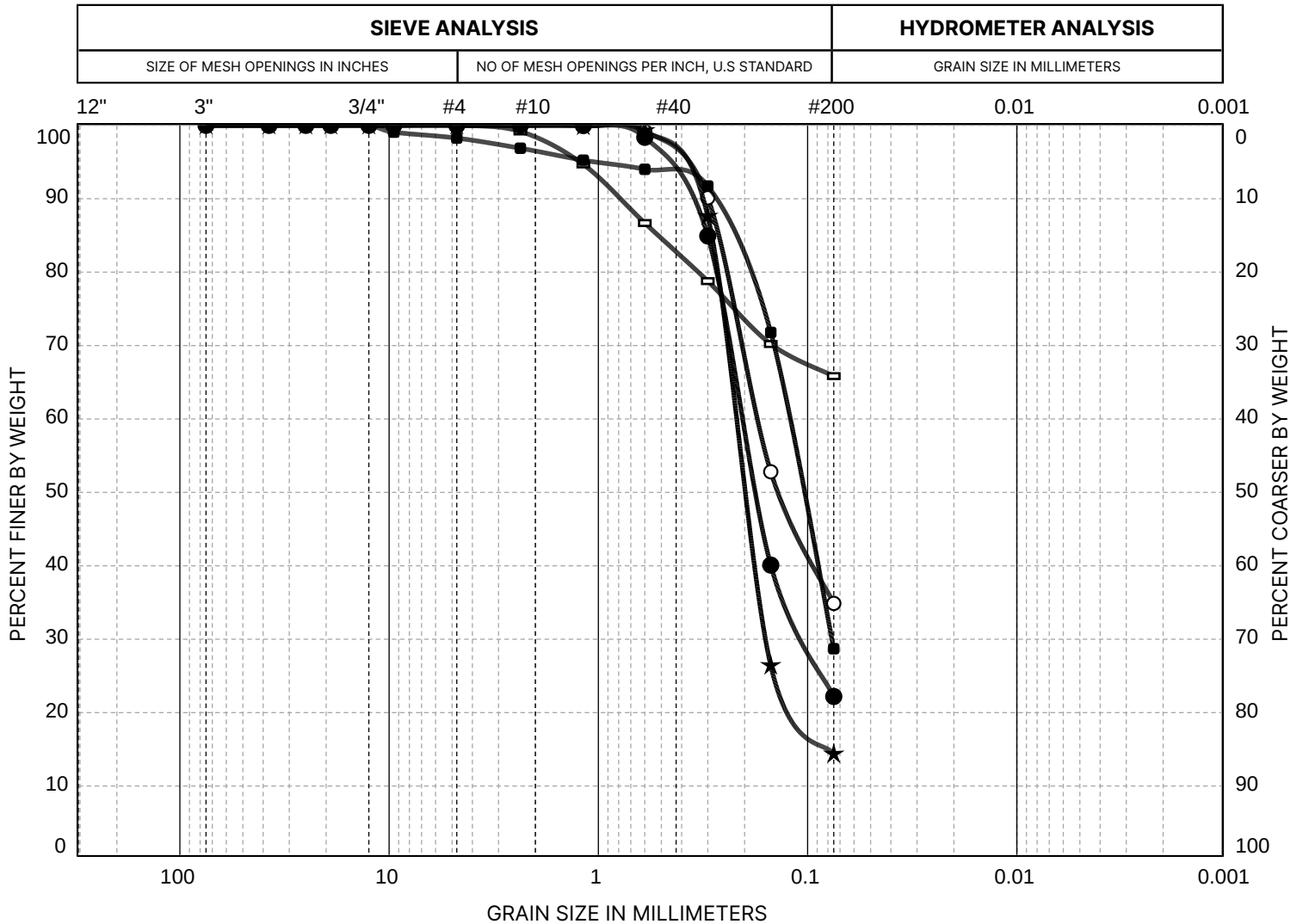
Campbell County High School  
44.171, -105.2915



|   | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH | GRAVEL (%) | SAND (%) | FINES (%) | D10  | D30  | D60   | D100  | CU | CC |
|---|--------------------|---------------|-------|------------|----------|-----------|------|------|-------|-------|----|----|
| ■ | B-6                | 7             | 20    | 0.00       | 85.69    | 14.31     | 0.15 | 0.21 | 13.29 |       |    |    |
| ▲ | B-7                | 7             | 20    | 1.91       | 43.38    | 54.71     |      |      | 0.08  | 13.29 |    |    |
| ● | B-8                | 6             | 15    | 0.86       | 84.35    | 14.79     | 0.14 | 0.21 | 13.29 |       |    |    |
| ◆ | B-8                | 2             | 2.5   | 1.11       | 87.57    | 11.32     | 0.17 | 0.21 | 13.29 |       |    |    |
| ◆ | B-7                | 4             | 7.5   | 0.00       | 30.73    | 69.27     |      |      |       | 13.29 |    |    |



Campbell County High School  
44.171, -105.2915

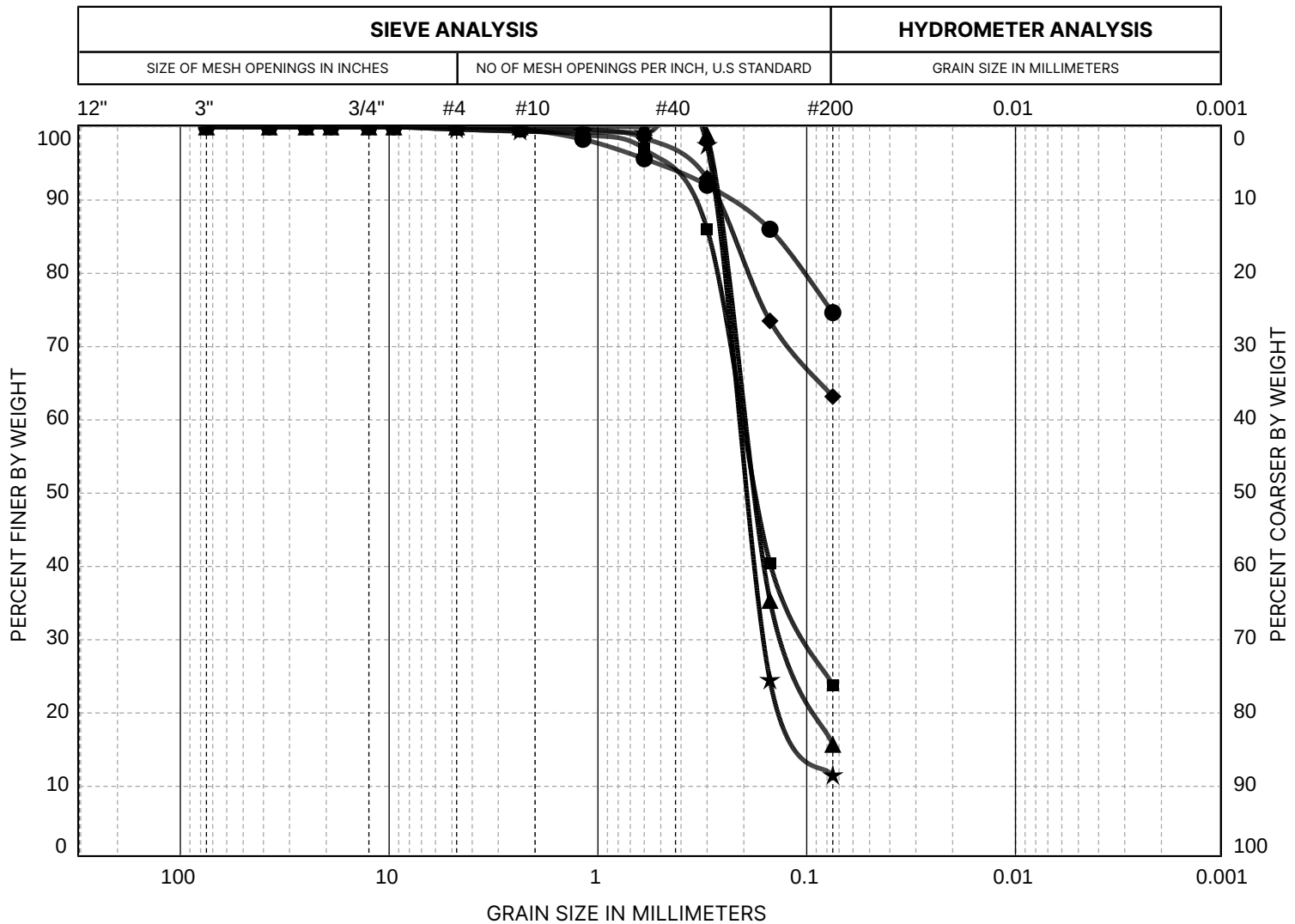


| COBBLES | GRAVEL |      | SAND   |        |      | FINES: SILT OR CLAY |
|---------|--------|------|--------|--------|------|---------------------|
|         | COARSE | FINE | COARSE | MEDIUM | FINE |                     |

|   | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH | GRAVEL (%) | SAND (%) | FINES (%) | D10  | D30  | D60  | D100  | CU | CC |
|---|--------------------|---------------|-------|------------|----------|-----------|------|------|------|-------|----|----|
| ○ | B-10               | 4             | 7.5   | 0.00       | 65.12    | 34.88     |      |      | 0.17 | 13.29 |    |    |
| □ | B-11               | 5             | 10    | 0.00       | 34.16    | 65.84     |      |      |      | 13.29 |    |    |
| ● | B-12               | 4             | 7.5   | 0.00       | 77.80    | 22.20     | 0.11 | 0.2  |      | 13.29 |    |    |
| ■ | B-10               | 8             | 25    | 1.74       | 69.54    | 28.71     | 0.08 | 0.12 |      | 13.29 |    |    |
| ★ | B-9                | 6             | 15    | 0.00       | 85.65    | 14.35     | 0.16 | 0.22 |      | 13.29 |    |    |



Campbell County High School  
44.171, -105.2915

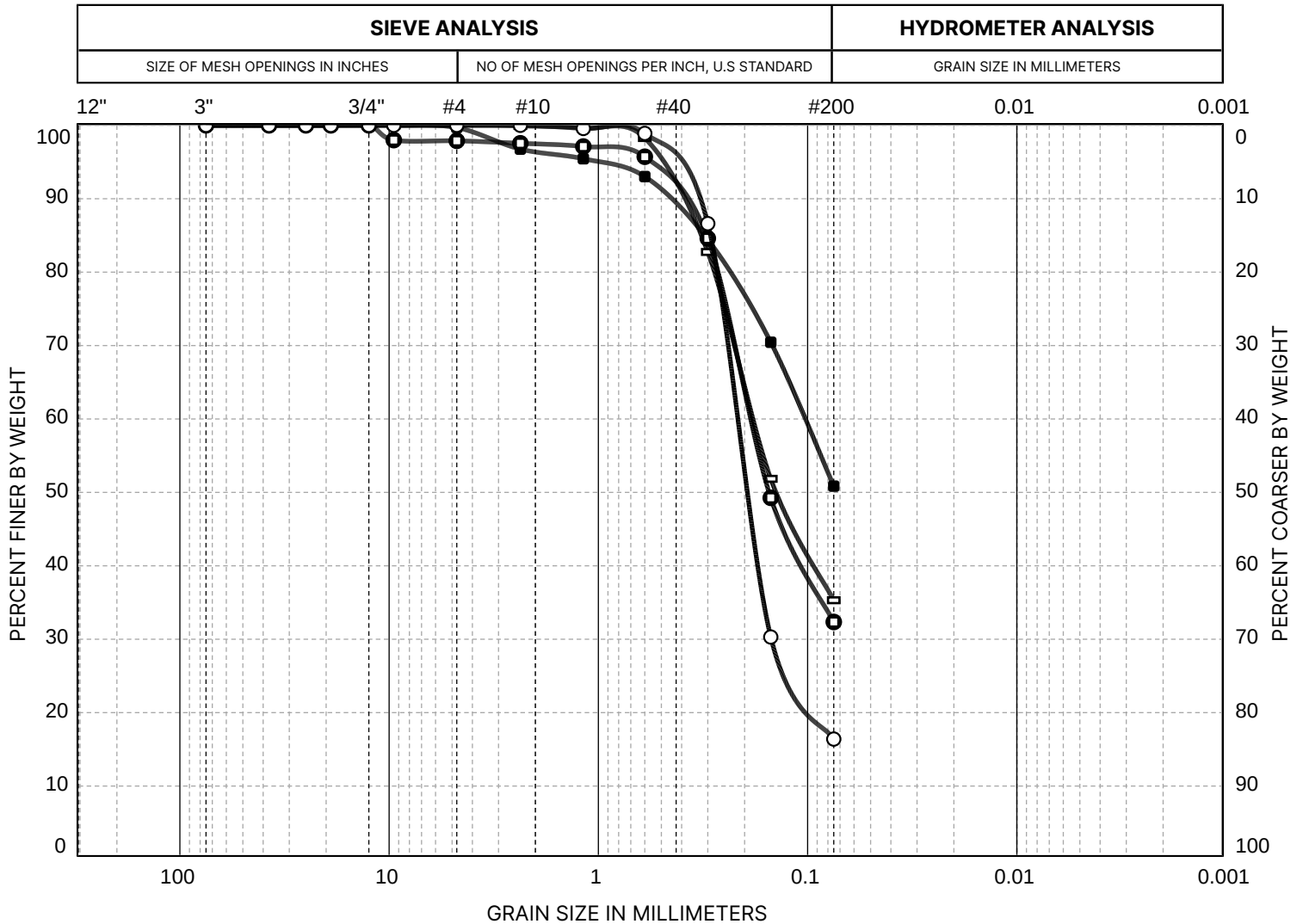


| COBBLES | GRAVEL |      | SAND   |        |      | FINES: SILT OR CLAY |
|---------|--------|------|--------|--------|------|---------------------|
|         | COARSE | FINE | COARSE | MEDIUM | FINE |                     |

|   | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH | GRAVEL (%) | SAND (%) | FINES (%) | D10 | D30  | D60  | D100  | CU | CC |
|---|--------------------|---------------|-------|------------|----------|-----------|-----|------|------|-------|----|----|
| ▲ | B-14               | 5             | 10    | 0.00       | 84.26    | 15.74     |     | 0.13 | 0.19 | 13.29 |    |    |
| ◆ | B-14               | 3             | 5     | 0.00       | 36.81    | 63.19     |     |      |      | 13.29 |    |    |
| ● | B-15               | 2             | 2.5   | 0.00       | 25.36    | 74.64     |     |      |      | 13.29 |    |    |
| ■ | B-13               | 3             | 5     | 0.36       | 75.83    | 23.81     |     | 0.1  | 0.2  | 13.29 |    |    |
| ★ | B-16               | 2             | 2.5   | 0.34       | 88.22    | 11.44     |     | 0.16 | 0.21 | 13.29 |    |    |

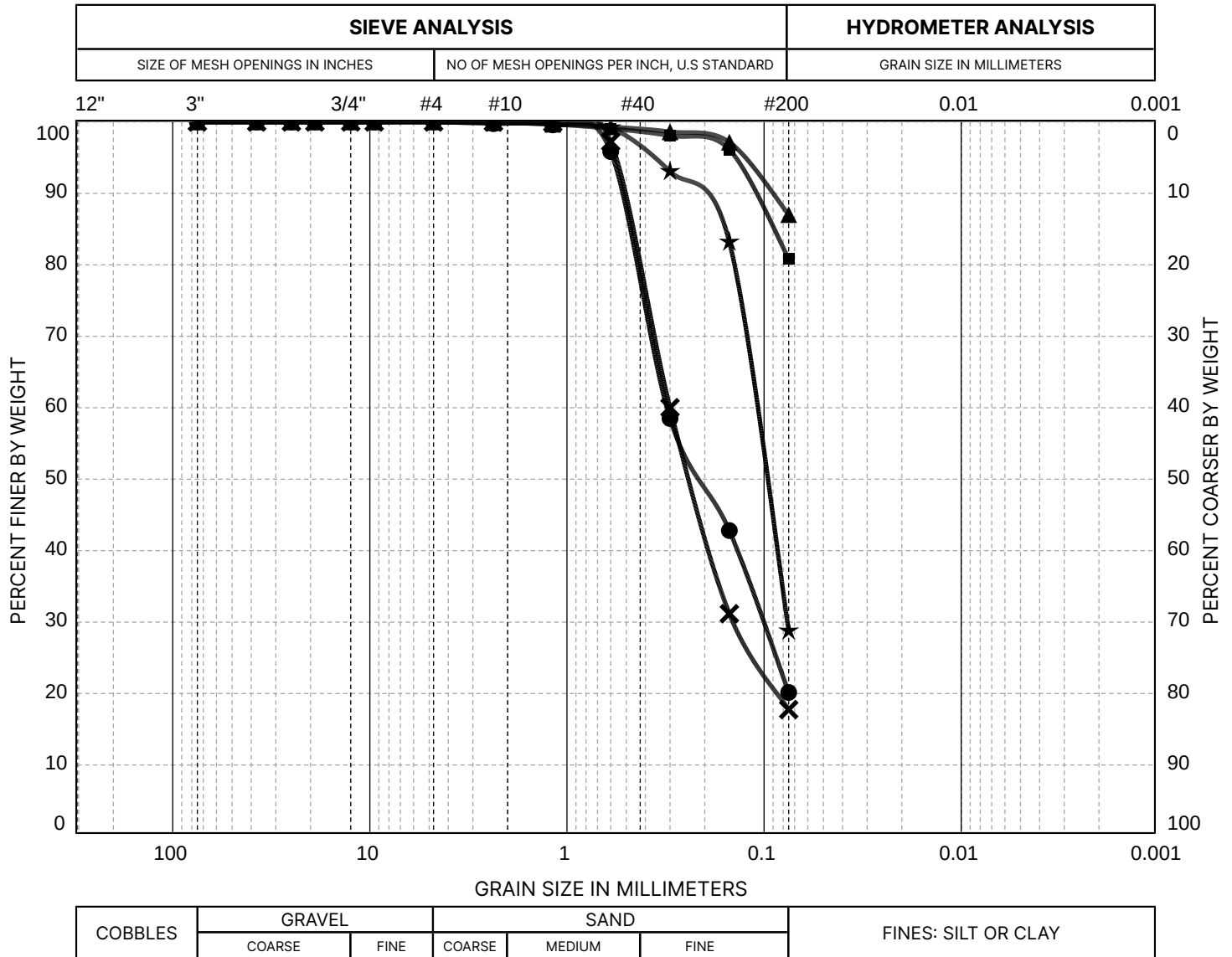


Campbell County High School  
44.171, -105.2915





Campbell County High School  
44.171, -105.2915



|   | EXPLORATION NUMBER | SAMPLE NUMBER | DEPTH | GRAVEL (%) | SAND (%) | FINES (%) | D10 | D30  | D60  | D100  | CU | CC |
|---|--------------------|---------------|-------|------------|----------|-----------|-----|------|------|-------|----|----|
| ■ | B-22               | B22 3         | 5     | 0.00       | 19.13    | 80.87     |     |      |      | 13.29 |    |    |
| ✕ | B-22               | B22 6         | 15    | 0.00       | 82.25    | 17.75     |     | 0.14 | 0.3  | 13.29 |    |    |
| ▲ | B-23               | B23 2         | 2.5   | 0.00       | 12.97    | 87.03     |     |      |      | 13.29 |    |    |
| ● | B-23               | B23 5         | 10    | 0.00       | 79.85    | 20.15     |     | 0.1  | 0.31 | 13.29 |    |    |
| ★ | B-24               | B24 3         | 5     | 0.00       | 71.23    | 28.77     |     | 0.08 | 0.11 | 13.29 |    |    |



---

## **GLOSSARY**

*Definition of certain words, terms or phrases that are used in this report are provided below, to help the reader to interpret the intent of Inberg Miller Engineers. These definitions:*

- 1. May differ from other published versions*
- 2. Have not been vetted by any organization outside of Inberg-Miller Engineers*
- 3. May not present a complete understanding of the term*

*The reader is encouraged to seek additional interpretation of important terms and consult with Inberg- Miller Engineers as necessary where discrepancies may be discovered, or a definition has not been provided.*

**Active Lateral Soil Pressure** – Horizontal pressure applied by soil to a wall that sufficiently yields or rotates about its base to allow the full soil shear strength to be mobilized

**Allowable End Bearing Pressure** – Recommended maximum pressure on soil or rock expressed as load per unit area that can be applied across the full bottom bearing surface of a pier or pile deep foundation within a given settlement tolerance

**Allowable Skin Friction** – Recommended maximum frictional resistance of soil or rock as load per unit area that can be applied over the vertical side surface of a pier or pile deep foundation within a given settlement tolerance.

**Alluvium** – Soil that has been transported and deposited in a moving water environment

**At-Rest Lateral Soil Pressure** - Horizontal pressure applied by soil to a wall or the vertical face of a structure that is restrained from movement and soil is not allowed to deform

**Backfill** – Soil that is used to replace some or all of soil that was excavated, and is usually subject to material specifications and density requirements

**Base** – Either 1: the bottom surface of a structure or excavation, or 2: soil or aggregate that is placed immediately below a structure or pavement

**Bearing Elevation** – A subsurface level where the base of foundations rest and transmit applied load to the soil or rock

**Bearing Stratum** – A specific soil layer defined by soil description and depth below ground surface, or elevation, to which foundations transmit applied load

**Claystone** – Consolidated sedimentary bedrock comprised chiefly of clay sized particles

**Collapse** – Loss of inter-particle soil friction, usually as a result of the effects of excessive moisture or water, and often leading to large subsidence or settlement of supported structures

**Colluvium** – Soil that has accumulated as a result of gravitational transport, commonly found near the base of slopes

**Compaction/Compacted** – Process or the result of a process where soil density is increased, soil voids are decreased, and usually resulting in an increased strength and reduced settlement potential

---

**Compressibility** – Relative term applied to soil or soil layer to describe how much it may yield to expected applied load or pressure

**Conglomerate** – A mixture of clay through gravel-size particles, commonly cemented with calcium carbonate

**Consistency** – Term applied to cohesive soils to describe relative stiffness, often defined by either ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils or as indicated by unconfined compressive strength

**Continuous Footing** – A long narrow footing usually supporting a linear structure such as a wall. Length to width ratio may vary but is commonly taken as 10.

**Contraction Joints** – Formed or sawn joints in concrete slabs or pavements used to control crack patterns that result from thermal contraction or shrinkage

**Crushed Aggregate Base** – Processed gravel at a specified grading and quantity of fractured faces, and sometimes certain durability requirements, that is used below slabs or pavements

**Cut** – Term applied to the volume or depth of soil that has been excavated to a certain design grade

**Cut Slope** – Soil or rock slope that results from cut or excavation

**Density** – The weight of soil for a unit volume, which may be stated in a dry condition, or a moist to saturated condition with weight of water included

**Dewatering** – Process of removing water from an excavation or lowering the groundwater elevation usually via drains or pumps

**Differential Settlement** – The difference in subsidence of a soil surface, or structure resting on soil, between two points spaced a certain distance apart

**Disturbed Soil** – Soil that has been loosened usually as a result of excavation activity, traffic, vibration

**Embedment** – The portion of a structure buried within a specific stratum, usually measured as a vertical distance

**Engineered Fill** – Soil that meets a specific gradation criteria and/or other quality requirements and that is placed at a specified thickness and moisture content and compacted to meet certain minimum density requirements, for the purpose of consistently obtaining certain minimum engineering properties for design

**Envelope A** – Specified gradation criteria that describes reasonably well graded sand and gravel mixtures, with less than 20 percent silt and clay.

**ESAL** – Criteria that describes traffic loading equivalent to a certain number of passes from an 18 kip single axle

**Excavation Subgrade** – The bottom of an excavation

**Expansion Joints** – Joints that are formed in a concrete pavement or slab that allow for thermal expansion of the concrete. Joints are usually filled with an elastic material to prevent entry of foreign particles

**Factor of Safety** – A multiplier for recommended allowable values that provides a margin for safety against failure, considering uncertainty and risk

**Fill** – Soil or rock that has been placed to raise the ground surface elevation

---

**Footing/Foundation Subgrade** – The surface of soil or rock to receive a structure which is usually a reinforced cast-in-place concrete

**Friction Angle** – A measure of physical resistance against sliding between soil or rock particles, usually ranging between 0 and 45 degrees

**Frost Heave** – A phenomenon that occurs in certain soil types where soil-moisture may concentrate and freeze as ice layers, causing upward swelling of the soil

**Frost Protection** – Any measure used to prevent frost-heave from affecting a structure

**Frost Susceptibility** – Soil types that are prone to frost heave

**Geotechnical Engineer** – An engineer trained through education and experience in soil mechanics and earth-structure systems

**Grade Beam** – A horizontal structural element that spans between foundations which may carry a portion of load from a structure above, but usually doesn't rely upon support from the soil below

**Heave** – The upward swelling of soil or rock, usually as a result of freezing or moisture adsorption

**Helical Screw Pile/Pier** – A foundation type that consists of a steel shaft with steel helices welded to the shaft, so that the system will pull itself into the ground when torque is applied

**Hydraulic Conductivity** – The rate at which water passes through soil under a certain pressure, usually expressed in the units of centimeters per second

**Hydrostatic Pressure** – The hydraulic pressure at a certain depth below the surface of a water body or water in saturated soil equivalent to the weight of water multiplied by the depth

**Isolated Pad Footing** – A single footing for the support of a leg, column, stanchion or other vertical structural element

**Lifts** – Layers of material that are placed as fill, backfill or pavement

**Mat Foundation** – A large, shallow spread footing that may support any combination of multiple point or area loads

**Maximum Allowable Bearing Pressure** – The recommended maximum pressure that may be applied to soil or rock, including a factor of safety, within estimated settlement tolerances

**Maximum Dry Density** – The peak soil density that is determined in a laboratory using a drop-hammer and mold over a range of varying moisture contents, expressed in terms of dry weight per unit volume

**Moisture Sensitivity** – A characteristic of soil that describes how the strength or compressibility is affected by increasing moisture content

**Moisture Vapor Control** – A design measure to limit the upward movement of soil moisture, usually through a concrete floor slab resting on the soil

**Native Soil** – Soil that is present naturally at a subject site

**On-Site Fill** – Soil used as fill or backfill that originates from a source located at the subject site

**Optimum Moisture Content** – The moisture content at which the maximum dry density is achieved in laboratory testing

---

**Organic Materials** – Matter contained in soil that is subject to decomposition

**Overburden** – Soil or rock that is present above an ore body, sedimentary bedrock or certain deposit such as gravel

**Overexcavation** – A process by which usually unsuitable or unwanted soil or rock is removed or excavated below the bottom of a structure or minimum required excavation limits

**Passive Lateral Soil Pressure** – Available resisting soil pressure when a structure is forced against the soil

**Pavement Subbase** – A specified soil type, often described by gradation that is placed below base, which in turn supports flexible or rigid pavement

**Perched Groundwater** – A subsurface condition where water collects above a relatively low permeability stratum

**Permeability** – The rate at which a liquid or gas may pass through soil, rock or other material

**Pile/Pier Cap** – A reinforced concrete block designed to distribute load from a structure to multiple deep foundation elements

**Proof-Rolling** – A process by which a subgrade is subjected to wheel loading to locate relative soft or yielding areas that might be repaired before covering with structures, soil, pavement etc.

**Raft Foundation** – See Mat Foundation

**Residual Soil** – Soil that has resulted from the in-place weathering of rock

**Rigid Pavement** – Usually reinforced or unreinforced Portland cement concrete, which when cured exhibits high compressive strength but is relatively inflexible

**Sandstone** - Sedimentary bedrock comprised chiefly of sand sized particles

**Saturation** – A condition where the pores of soil or rock are completely filled with water

**Sedimentary Bedrock** – Consolidated sediments of clay, silt or sand

**Shrink-Swell Potential** – Likelihood that soil or rock may increase or decrease in volume, usually as result of water adsorption and indicated by high plasticity index and/or measured response to inundation

**Siltstone** - Sedimentary bedrock comprised chiefly of silt sized particles

**Site Fill** – Soil used to raise the grade of all or a portion of a site to a design elevation, exclusive of structures or buildings

**Slab Fill** – Soil used to fill above the foundation bearing elevation to the bottom of any special subbase or base soil/aggregate that supports a concrete slab-on-grade

**Slab Subbase** – Soil that meets a specified gradation requirement or other criteria for placement below a base aggregate

**Spread Footing/Foundations** – A foundation type that usually consists of a reinforced, cast-in-place concrete that is formed in a round, square, rectangle or continuous strip shape for transferring structural loads to the soil and is placed at certain minimum depths for frost protection or confinement

**Stripping Depth** – The depth below ground surface that unsatisfactory soil or other materials should be removed before placement of engineered fill or structures

---

**Structural Fill** – Soil that meets a specified gradation or other quality or strength criteria for the purpose of raising the ground surface elevation or improving bearing conditions to receive a structure

**Subgrade** – Soil surface or substrate that will receive pavement, structure, engineered fill, backfill etc.

**Synthetic Reinforcement** – Specially manufactured fabric, usually as a woven or extruded plastic, used for the purpose of forming a composite with soil or aggregate and adding strength

**Synthetic Separation** - Specially manufactured fabric, usually as a woven plastic or non-woven fibrous plastic, used for the purpose creating a barrier for the migration of fine-grained soil

**Topsoil** – Soil that contains organic matter, usually as decayed vegetation and roots, in sufficient quantity that it is compressible, moisture sensitive, or subject to settlement with continued decay

**Total Settlement** – An estimate of the amount of settlement that may occur over the life of a structure as a result of compression of underlying soil due to the pressure imposed by the structure

**Transient Loading** – Short term loads applied to a structure, such as from seismic force or wind pressure.

**Ultimate Bearing Capacity** – An estimate of the bearing pressure applied to a soil stratum that would induce shear failure, without consideration of a factor of safety or limiting settlement

**Undisturbed Soil** – Soil that is allowed to remain in its natural state without changing moisture content or density

**Void Form** – A concrete form material for casting a structure which provides support long enough for the concrete to complete curing and gain sufficient strength for the structure to support itself, leaving a void when the form disintegrates with weathering and moisture.

**Water Table** – The surface of groundwater within saturated soil or rock layers

**Weathered Bedrock** – Native rock formation that has become delaminated or shows evidence of disintegration as determined and defined by the geotechnical engineer to distinguish a certain stratum for the purposes of the report

# GENERAL NOTES - LOG OF TEST BORING/TEST PIT

## DESCRIPTIVE SOIL CLASSIFICATION

### Grain Size Terminology

| Soil Fraction  | Particle Size        | U.S. Standard Sieve Size |
|----------------|----------------------|--------------------------|
| Boulders       | Larger than 12"      | Larger than 12"          |
| Cobbles        | 3" to 12"            | 3" to 12"                |
| Gravel: Coarse | 3/4" to 3"           | 3/4" to 3"               |
| Fine           | 4.76mm to 3/4"       | #4 to 3/4"               |
| Sand: Coarse   | 2.00mm to 4.76mm     | #10 to #4                |
| Medium         | 0.42mm to 2.00mm     | #40 to #10               |
| Fine           | 0.074mm to 0.42mm    | #200 to #40              |
| Silt           | 0.005mm to 0.074mm   | Smaller than #200        |
| Clay           | Smaller than 0.005mm | Smaller than #200        |

Plasticity characteristics differentiate between silt and clay

| Relative Density |            | Consistency |                              |
|------------------|------------|-------------|------------------------------|
| Term             | "N" Value* | Term        | q <sub>u</sub> -tons/sq. ft. |
| Very Loose       | 0-4        | Very Soft   | 0.0 to 0.25                  |
| Loose            | 4-10       | Soft        | 0.25 to 0.5                  |
| Medium Dense     | 10-30      | Firm        | 0.5 to 1.0                   |
| Dense            | 30-50      | Stiff       | 1.0 to 2.0                   |
| Very Dense       | Over 50    | Very Stiff  | 2.0 to 4.0                   |
|                  |            | Hard        | Over 4.0                     |

\*Note: The penetration number, N, is the summation of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140-pound weight falling 30", and is seated to a depth of 6" before commencing the standard penetration test.

## DESCRIPTIVE ROCK CLASSIFICATION

### Engineering Hardness Description of Rock

(not to be confused with MOH's scale for minerals)

|             |                                                                                                                                                                                                              |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Very Soft   | Can be carved with a knife. Can be excavated readily with point of pick. Pieces one inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.                    |
| Soft        | Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure. |
| Medium Soft | Can be grooved or gouged 1/16-inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-inch-maximum size by hard blows of the point of a geologist's pick.       |
| Medium Hard | Can be scratched with knife or pick. Gouges or grooves to 1/4-inch deep. Can be excavated by hard blow of a geologist's pick. Hand specimens can be detached by moderate blow.                               |
| Hard        | Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.                                                                                              |
| Very Hard   | Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.                                                                                    |

## NOMENCLATURE

### Drilling and Sampling

|    |    |                                                                                    |
|----|----|------------------------------------------------------------------------------------|
| SS | -- | Split Barrel (spoon) Sampler                                                       |
| N  | -- | Standard Penetration Test Number, blows/foot*                                      |
| ST | -- | Thin-walled Tube (Shelby Tube) Sampler                                             |
| DC | -- | Thick-wall, ring lined, drive sampler                                              |
| C  | -- | Coring                                                                             |
| DP | -- | Direct Push Sampler                                                                |
| CS | -- | Continuous Sampler (used in conjunction with hollow stem auger drilling)           |
| D  | -- | Disturbed Sample (auger cuttings, air/wash rotary cuttings, backhoe, shovel, etc.) |

### Laboratory Tests

|                |    |                                                             |
|----------------|----|-------------------------------------------------------------|
| USCS           | -- | Unified Soil Classification System (soil type)              |
| W              | -- | Water Content (%)                                           |
| LL             | -- | Liquid Limit (%)                                            |
| PL             | -- | Plastic Limit (%)                                           |
| PI             | -- | Plasticity Index (LL-PL) (%)                                |
| q <sub>u</sub> | -- | Unconfined Strength, TSF                                    |
| q <sub>p</sub> | -- | Penetrometer Reading (estimate of unconfined strength), TSF |
| Y <sub>m</sub> | -- | Moist Unit Weight, PCF                                      |
| Y <sub>d</sub> | -- | Dry Unit Weight, PCF                                        |
| WSS            | -- | Water Soluble Sulfate (%)                                   |
| Φ              | -- | Angle of Internal Friction (degrees)                        |
| c              | -- | Soil Cohesion, TSF                                          |
| SG             | -- | Specific gravity of soil solids                             |
| S              | -- | Degree of Saturation (%)                                    |
| e              | -- | Void Ratio                                                  |
| n              | -- | Porosity                                                    |
| k              | -- | Permeability (cm/sec)                                       |

### Water Level Measurement



|                                                                                                                                                                                                                                                |                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| --                                                                                                                                                                                                                                             | Water Level at Time Shown |
| Note: Water level measurements shown on the boring logs represent conditions at the time indicated, and may not reflect static levels, especially in cohesive soils. The available water level information is given at the bottom of each log. |                           |

# CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D2487-69 and D2488-69 (Unified Soil Classification System)

| Major Divisions                                                                        |                                                                                |                                                   | Group Symbols   |                                                                                                                     | Typical Names                                                   |                                                     | Laboratory Classification Criteria                                                                                                                                                                                                   |                                                                                                              |                                                        |  |
|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--|
| Coarse-Grained Soils<br>(More than half of material is larger than No. 200 sieve size) | Gravels<br>(More than half of coarse fraction is larger than No. 4 sieve size) | Clean Gravels<br>(Little or no fines)             | GW              |                                                                                                                     | Well graded gravels, gravel-sand mixtures, little or no fines   |                                                     | Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:<br><br>GW, GP, SW, SP<br>GM, GC, SM, SC | $C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(C_{30})^2}{D_{10} \times D_{60}}$ between 1 & 3  |                                                        |  |
|                                                                                        |                                                                                |                                                   | GP              |                                                                                                                     | Poorly Graded gravels, gravel-sand mixtures, little or no fines |                                                     |                                                                                                                                                                                                                                      | Not meeting all gradation requirements for GW                                                                |                                                        |  |
|                                                                                        |                                                                                | Gravels w/ Fines<br>(Appreciable amount of fines) | GM <sup>a</sup> | d                                                                                                                   | Silty gravels, gravel-sand-silt mixtures                        | Atterberg limits below "A" line or P.I. less than 4 |                                                                                                                                                                                                                                      | Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols                  |                                                        |  |
|                                                                                        |                                                                                |                                                   |                 | u                                                                                                                   |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        | Sands<br>(More than half of coarse fraction is smaller than No. 4 sieve size)  | Clean Sands<br>(Little or no fines)               | GC              |                                                                                                                     | Clayey gravels, gravel-sand-clay mixtures                       |                                                     |                                                                                                                                                                                                                                      | $C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 & 3  |                                                        |  |
|                                                                                        |                                                                                |                                                   | SW              |                                                                                                                     | Well-graded sands, gravelly sands, little or no fines           |                                                     |                                                                                                                                                                                                                                      |                                                                                                              | Not meeting all gradation requirements for SW          |  |
|                                                                                        |                                                                                | Sands w/ Fines<br>(Appreciable amount of fines)   | SP              | Poorly graded sands, gravelly sands, little or no fines                                                             |                                                                 | Atterberg limits above "A" line or P.I. less than 4 |                                                                                                                                                                                                                                      | Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols |                                                        |  |
|                                                                                        |                                                                                |                                                   |                 | SM <sup>a</sup>                                                                                                     | d                                                               |                                                     |                                                                                                                                                                                                                                      |                                                                                                              | Silty sands, sand-silt mixtures                        |  |
|                                                                                        |                                                                                |                                                   | u               |                                                                                                                     |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        |                                                                                |                                                   | SC              |                                                                                                                     | Clayey sands, sand-clay mixtures                                |                                                     |                                                                                                                                                                                                                                      |                                                                                                              | Atterberg limits above "A" line or P.I. greater than 7 |  |
| Fine-Grained Soils<br>(More than half material is smaller than No. 200 sieve size)     | Silts and Clays<br>(Liquid limit less than 50)                                 | ML                                                |                 | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity |                                                                 | <div>Plasticity Chart</div>                         |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        |                                                                                | CL                                                |                 | Inorganic clays of low to medium plasticity, gravelly, clays, sandy clays, silty clays, lean clays                  |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        |                                                                                | OL                                                |                 | Organic silts and organic silty clays of low plasticity                                                             |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        | Silts and Clays<br>(Liquid limit greater than 50)                              | MH                                                |                 | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts                                 |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        |                                                                                | CH                                                |                 | Inorganic clays of high plasticity, fat clays                                                                       |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        |                                                                                | OH                                                |                 | Organic clays of medium to high plasticity, organic silts                                                           |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |
|                                                                                        | Highly Organic Soils                                                           | P <sub>t</sub>                                    |                 | Peat and other highly organic soils                                                                                 |                                                                 |                                                     |                                                                                                                                                                                                                                      |                                                                                                              |                                                        |  |

<sup>a</sup> Division of GM and SM groups into subdivision of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

<sup>b</sup> Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.



# Important Information about Your Geotechnical-Engineering Report

*Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.*

*While you cannot eliminate all such risks, you can manage them. The following information is provided to help.*

## Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply the report for any purpose or project except the one originally contemplated.*

## Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

## A Geotechnical-Engineering Report Is Based on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that 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.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

## Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical-engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

## Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

## A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual



subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

### **A Geotechnical Engineering Report Is Subject to Misinterpretation**

Other design team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical-engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

### **Do Not Redraw the Engineer's Logs**

Geotechnical engineers 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 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 mistakenly 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 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 the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time to perform additional study.* Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

### **Geoenvironmental Concerns Are Not Covered**

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

### **Obtain Professional Assistance To Deal with Mold**

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold-prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

### **Rely on Your GBA-Member Geotechnical Engineer for Additional Assistance**

Membership in the GEOPROFESSIONAL BUSINESS ASSOCIATION exposes geotechnical engineers to a wide array of risk confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your GBA-member geotechnical engineer for more information.



**GEOPROFESSIONAL  
BUSINESS  
ASSOCIATION**

8811 Colesville Road/Suite G106, Silver Spring, MD 20910

Telephone: 301/565-2733 Facsimile: 301/589-2017

e-mail: [info@geoprofessional.org](mailto:info@geoprofessional.org) [www.geoprofessional.org](http://www.geoprofessional.org)

Copyright 2014 by Geoprofessional Business Association, Inc. (GBA). Duplication, reproduction, or copying of this document, in whole or in part, by any means whatsoever, is strictly prohibited, except with GBA's specific written permission. Excerpting, quoting, or otherwise extracting wording from this document is permitted only with the express written permission of GBA, and only for purposes of scholarly research or book review. Only members of GBA may use this document as a complement to or as an element of a geotechnical-engineering report. Any other firm, individual, or other entity that so uses this document without being a GBA member could be committing negligent or intentional (fraudulent) misrepresentation.



CIVIL | GEOTECHNICAL | ENVIRONMENTAL | MATERIALS TESTING | SURVEYING | DRILLING

## SECTION 312201 - GRADING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Removal and storage of topsoil.
- B. Rough grading the site.
- C. Finish grading.

#### 1.02 RELATED REQUIREMENTS

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report; bore hole locations and findings of subsurface materials.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 311000 - Site Clearing
- D. Section 312316 - Excavation
- E. Section 312316.13 - Trenching
- F. Section 312323 - Fill
- G. Section 329201 - Reclamation
- H. Section 329202 - Landscaping

#### 1.03 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
- C. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
- E. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

#### 1.04 JOB CONDITIONS

- A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. Data is made available for the convenience of the Contractor. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.

- B. Existing Utilities: The underground utilities shown on the plans are per utility locates performed by others, existing drawings, observed physical evidence, and per communication with utility providers. The locations shown on the drawings are only as accurate as the information provided. Additional active and/or abandoned utilities may exist. It is the responsibility of the Contractor to notify all utility companies and to determine the exact location of all utilities prior to commencement of work.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult the utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
2. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when permitted in writing by Architect/Engineer and then only within allowable periods for down time, or after acceptable temporary utility service have been provided.
3. Contractor shall demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies, or Owner, for shut-off of service if lines are active.

#### 1.05 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

#### 1.06 QUALITY ASSURANCE

- A. Perform work in accordance with the Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025).

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Topsoil: Shall consist of any soil suitable for the growth of grass or other cover crops. It shall be a fertile, friable material; loam or sandy clay loam. It shall not be saline or sodic and shall not contain noxious weeds or toxic substances. To a depth of 6 inches the soil shall be free of roots, branches, hard dirt, clay, pieces of concrete, sticks, stones or any other materials that would inhibit the germination of seeds or the growth of the cover crop. Classification of soils suitable for topsoil will be at the discretion of the Architect/Engineer.
- B. Explosives: The use of explosives is not permitted.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verify that survey benchmark and intended elevations for the Work are as indicated.
- B. Verify the absence of standing or ponding water.

#### 3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect from damage above and below grade utilities to remain.

- D. Notify utility company to remove and relocate utilities.
- E. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.
- F. Protect site features to remain, including but not limited to benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.
- G. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
- H. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

### 3.03 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, relandscaped, or regraded, without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, relandscaped, or regraded.
- D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- E. See Section 312323 - Fill for filling procedures.
- F. Benching Slopes: Horizontally bench existing slopes greater than 4H:1V to key fill material to slope for firm bearing.
- G. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- H. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of surface water control.
- I. After the earthwork has been substantially completed and after all underground utilities have been installed or adjusted to grade, the subgrade shall be brought to the lines, grades, and cross-sections shown in the plans, and compacted to the required density.
- J. At all times, ditches and drains along the subgrade shall be so maintained as to drain effectively. When ruts of 2 inches or more in depth are formed, the subgrade shall be brought to grade and if necessary, be reshaped and re-rolled.
- K. If it should become necessary, because of weather or other conditions, to suspend rough grading operations, the entire area worked upon shall be bladed until smooth, free of depressions and ruts, and crowned so that no water can collect or be impounded.

### 3.04 SOIL REMOVAL and STOCKPILING

- A. Stockpile topsoil to be reused on site; remove remainder from site.
- B. Stockpile subsoil to be reused on site; remove remainder from site.
- C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

### 3.05 SUBGRADE PREPARATION

- A. The top 12 inches of subgrade shall be scarified, moisture conditioned and re-compacted. Scarification shall include thorough mixing, blending, aerating, discing, and moisture conditioning of the entire hardscape surface. Work shall also include the filling in or cleaning of ditches and re-establishment of drainage at designated locations as shown in the Plans or directed by Architect/Engineer. Subgrade preparation will not be completed in areas that require excavation below subgrade, unless directed by the Architect/Engineer.
  - 1. Excavation below subgrade shall consist of the excavation and disposal of unstable or unsuitable materials in the subgrade as directed by the Architect/Engineer. These areas shall be excavated to the extent determined by the Architect/Engineer and remediated as directed by the Architect/Engineer.
  - 2. All boulders appearing in the earth excavation shall be removed or broken off to a depth of not less than 4 inches below subgrade.
  - 3. The subgrade shall be graded to the neat lines shown in the plans and compacted as specified.
- B. The Contractor shall provide watering and rolling as required to obtain the density of 90% of maximum dry density for all locations outside hardscaped areas and 93% under hardscaped areas. The amount of water required for rolling shall be within plus 2% to minus 2% of optimum moisture content as determined by ASTM D698.
- C. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density. Soil material that has been removed because it is too wet to permit compaction may be stockpiled at an approved location or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory level.
- D. Where moisture must be added, uniformly apply water to surface or layer of soil material to prevent free water appearing on surface during or subsequent to compaction operations. Then thoroughly mix the material.
- E. If acceptable material becomes unacceptable due to precipitation, snow melt, drying, or otherwise, the Contractor shall rework the area until it is acceptable.
- F. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- G. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

### 3.06 FINISH GRADING

- A. Before Finish Grading:
  - 1. Verify building and trench backfilling have been inspected.
  - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove soil contaminated with petroleum products.
- C. Where topsoil is to be placed, scarify surface to depth of 3 inches.
- D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 6 inches.
- E. Place topsoil in areas indicated.
- F. Place topsoil where required to level finish grade.



- G. Place topsoil to nominal depth of 6 inches.
- H. Place topsoil during dry weather.
- I. Remove roots, weeds, rocks, and foreign material while spreading.
- J. Near plants spread topsoil manually to prevent damage.
- K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- L. Compact placed topsoil per the Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025).
- M. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.
- N. If it should become necessary, because of weather or other conditions, to suspend finish grading operations, the entire area worked upon shall be bladed until smooth, free of depressions and ruts, and crowned so that no water can collect or be impounded.

### 3.07 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

### 3.08 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect/Engineer as to remedy.
- C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

### 3.09 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Owner will engage soil testing/inspection service from a qualified testing laboratory acceptable to the Architect/Engineer for quality testing during construction per 014000 - Quality Requirements.
- C. Testing laboratory shall provide Architect/Engineer with copies of all test reports within 24 hours of tests.
- D. Contractor shall allow testing service to inspect and Architect/Engineer to approve subgrade and fill layers before further construction work is performed.
- E. In-place quality control density testing shall be completed in accordance with ASTM D6938 or ASTM D1556/D1556M. Testing may be accomplished using a nuclear gage in accordance with ASTM D6938. The gage shall be calibrated in accordance with the annex of ASTM D6938.

- F. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor") or AASHTO T 180 ("modified Proctor").
- G. If tests indicate materials do not meet specified requirements, the Contractor shall provide additional compaction, watering or drying, blending of material, and/or remove and replace work before retesting at no additional cost.
- H. Should conditions become present following a passing compaction test that cause a change in the conditions of the compacted crushed aggregate base course (such as precipitation from a storm event) prior to the placement of a subsequent lift or section, then the area(s) shall be retested, at the discretion of the Architect/Engineer, to confirm adequate compaction.
- I. Subgrade within paved areas shall be accepted for density on a lot basis consisting of 500 square yards. Sampling locations will be determined by the testing laboratory, or as directed by the Architect/Engineer, on a random basis in accordance with ASTM D3665.
- J. Compaction tests taken for subbase under curb and gutter shall be taken at a minimum of one density test per 150 linear feet.
- K. Compaction tests taken for subbase under sidewalk shall be taken at a minimum of one density test per 500 square feet.
- L. Proof Rolling: Compacted satisfactory subbase for paved areas shall further be determined by proof-rolling with equipment approved by the Architect/Engineer prior to use. Proof-rolling equipment shall be a loaded tandem axle dump truck, or similar piece of equipment, having pneumatic tires and weighing not less than 27 tons. Each succeeding pass of the proof-roller over the roadbed shall be offset by not greater than one tire width. Limit vehicle speed to 3 mph. Excavate soft spots and areas of excessive pumping or rutting, as determined by Architect/Engineer, and replace with compacted material as directed.

#### 3.10 CLEANING

- A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 312201



## SECTION 312316.13 - TRENCHING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Performing all operations in connection with all excavation, pipe bedding, backfilling, consolidation and compaction of backfill; dewatering and protection work; and final grading and dressing of the surface for installation of utility lines, utility service lines and appurtenances.

#### 1.02 RELATED REQUIREMENTS

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report; bore hole locations and findings of subsurface materials.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 312201 - Grading
- D. Section 312323 - Fill
- E. Section 330200 - Underground Utilities
- F. Section 330500 - Manholes
- G. Section 331100 - Water Main
- H. Section 331120 - Fire Hydrants
- I. Section 331150 - Water Service
- J. Section 333100 - Sanitary Sewer Piping
- K. Section 334200 - Storm Sewer Piping
- L. Section 334210 - Culverts
- M. Section 334250 - Storm Sewer Inlets

#### 1.03 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: Indicated on drawings.

#### 1.04 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction.
- B. OSHA 2226 - 2015 - Occupational Safety and Health Administration Trenching and Excavation Safety; current Edition.
- C. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

- D. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- G. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- H. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

#### 1.05 SUBMITTALS

- A. Certificates of Compliance: Contractor shall submit Certificates of Compliance for all imported materials showing they comply with these Specifications before any materials will be approved for use.
- B. Compaction Density Test Reports.

#### 1.06 QUALITY ASSURANCE

- A. Perform work in accordance with the referenced geotechnical engineering report.
- B. Field density tests of the compacted backfill shall be performed at all levels. The frequency of testing utility line(s), service line trenches, manholes, valve boxes and utility appurtenances shall be as follows:
  - 1. Trenches: Minimum of 3 compaction compliance tests for every 150 lineal feet of trench. The 3 compliance tests on backfill shall be taken at different elevations in the trench. The recommended elevation where the 3 tests should be taken are 1 test 4 feet or more below grade and 2 tests in the top 4 feet at approximately 2 foot intervals for trenches 8 feet in depth or less. For trenches greater than eight feet in depth, at a minimum, an additional test shall be taken for every 2 feet of additional trench depth.
  - 2. Manholes, storm drain inlets, and valve boxes: 100% of the total manholes, storm drain inlets and valve boxes shown in the Plans and located within the roadway section shall be tested. Testing shall be every 2 feet of vertical depth as shown in the Plans.
  - 3. The vertical depth is defined as the distance from the top of proposed final surface to the top of utility pipe as shown in the Plans. Each test shall be taken in 2 foot vertical increments. The lowest elevation a test shall be performed is 12 inches above the pipe bedding. The highest elevation a test shall be performed shall be one foot below the subgrade. These tests will be performed to ensure that the specified density is obtained. The Contractor will be responsible for scheduling all testing.
- C. The Contractor shall provide safe access to all areas of backfill for the Architect/Engineer to perform density testing, if requested by the Architect/Engineer.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Storage of all imported backfill materials is the responsibility of the Contractor, as is the protection of said materials from adverse conditions which would disqualify them from use under this specification.

## PART 2 PRODUCTS

### 2.01 CLASSIFICATION OF TRENCH EXCAVATED MATERIAL

- A. No classification of trench excavated materials will be made by Owner or Architect/Engineer. Excavation and trenching work shall include the removal and subsequent handling of all earth, shale, loose or cemented gravel, loose rock, solid rock, and/or other material(s) excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof. It shall also include the removal and disposal of all vegetation, debris, junk, broken asphalt pavement, broken concrete, brick, stone, and other materials encountered within the trench excavation.

### 2.02 WATER

- A. Shall be clean and free from harmful substances.

### 2.03 FILL MATERIALS

- A. Imported Bedding Material: Aggregate shall be free from vegetable matter, lumps or balls of clay, frozen material, adherent films of clay or other matter which will prevent it from flowing. The material shall be non-plastic in accordance with ASTM D4318.
  - 1. For pressurized pipelines where minor pipe settlement will not affect performance of the conduit, bedding material conforming to the Imported Type 1 or suitable processed Native Soil as listed below shall be placed from a point 6 inches below the bottom of the pipe to 6 inches above the top of the pipe, and a minimum of one foot on each side of the pipe.
  - 2. For gravity flow pipelines where grade of the pipe is critical to performance and minor settlements may be detrimental, imported bedding material conforming to the requirements of Type 1 or suitable processed Native Soil as listed below shall be placed from a point 6 inches below the bottom of the pipe to the spring-line. If installed as required by subsection 3.6 of this Section. From spring-line to 6 inches above the top of pipe, suitable processed Native Soil or imported Type 1 bedding material may be used.
  - 3. Where wet or otherwise unstable conditions exist, pipe bedding material shall have a Plasticity Index (PI) of 6 or less in accordance with ASTM D4318.
  - 4. Where metallic pipe, valves, or fittings are used, the material shall have an electrical resistivity greater than 5,000 ohm-cm in accordance with ASTM G57. This requirement includes metal valves and fittings on PVC pipe.
- B. Processed Native Soil Bedding Material
  - 1. Shall consist of native clay and/or sand material free from clods, frozen material, or stones larger than 3/4 inch in their maximum dimension. Where wet or otherwise unstable conditions exist, the material in this zone shall be free draining, non-plastic material. Where suitable material is available in the material excavated from the trench, the Contractor shall procure the select material by screening, sifting, or manually sorting the material removed from the trench in a manner approved by the Architect/Engineer.
  - 2. This native pipe bedding material shall be incidental to the associated pipe installation.
- C. Type 1 Pipe Bedding Material:
  - 1. When on-site native material is unsuitable or at the direction of the Architect/Engineer silt, clay, silty sand, silty gravel, or clayey sand or gravel (ASTM D2487 classification ML, CL, ML-CL, SM, SC, GM, GC, SW, SP) free of stones larger than 3/4 inch in their maximum dimension shall be used from 6 inches under the pipe to 6 inches over the pipe.

D. Imported Type 2 Pipe Foundation Material:

1. When authorized by the Architect/Engineer imported pipe foundation material shall be clean gravel or sand graded in accordance with ASTM C136/C136M, with the following limits:
  - 3 inch sieve: 100% passing
  - 1-1/2 inch sieve: 80-100% passing
  - 3/4 inch sieve: 35-70% passing
  - #200 sieve: 0-5% passing
2. Foundation material shall be used below the bedding zone. This material's purpose is to provide an acceptable foundation for the bedding and pipe when the native soils are found to be unacceptable per subsection 3.6 of this Section. It is not intended to assist in the dewatering process.

E. In unusual situations an alternative bedding material can be used if proposed by the Contractor for approval by the Architect/Engineer.

F. Imported Trench Backfill Material:

1. When authorized by the Architect/Engineer, imported trench backfill material shall be granular and free from ashes, cinders, organic material, debris, frozen material, and other unsuitable material.
2. Material shall also be:
  - a. A maximum size of 3 inches.
  - b. Material passing a #40 sieve shall not have a Plasticity Index (PI) in excess of 10.

G. Backfill Above Bedding:

1. Subsoil excavated on-site not containing debris, waste, frozen materials, snow, vegetation and other deleterious matter, or containing excessive moisture.

H. Structural Fill: Per recommendation of the geotechnical engineer.

I. Cement Treated Fill

1. Cement treated fill, when specified, shall meet the following criteria:

| Ingredient                     | LBS/CY   |
|--------------------------------|----------|
| Cement (0.45 Sack)             | 42 lbs   |
| Water (39 Gallons)             | 325 lbs  |
| Coarse Aggregate (Size No. 57) | 1700 lbs |
| Sand (ASTM C33/C33M)           | 1845 lbs |

J. Topsoil: See Section 312201 - Grading.

## 2.04 ACCESSORIES

A. Warning Tape: Heavy-gauge plastic tape used for marking underground utilities.

1. Minimum Thickness: 5 mil.
2. Minimum width: 3 inches.
3. Color: Conform to the American Public Works Association (APWA) Uniform Color Code.
4. Labeling: Shall be imprinted with an appropriate legend to define the type of utility labeled with bold black letters for full length of tape.
5. Tape shall be impervious to all known alkalis, chemical reagents, and solvents found in soil.
6. Tape shall have a maximum imprint length of 36 inches.

- B. Tracer Wire: Insulated wire resistant to corrosive soil and intended for extended direct burial service being Copperhead Superflex 1030, #10 AWG copper clad steel conductor with 30 mil HDPE insulation rated for direct bury, or Architect/Engineer approved equal, meeting the following requirements:
1. Wire: #10 AWG High Strength Copper Clad Steel (HS-CCS).
  2. Wire Insulation: High density polyethylene (HDPE) with minimum thickness of 30 mil.
  3. Electrical Load: 30 volts.
  4. 513 lb minimum break load.
  5. Color: Conform to the American Public Works Association (APWA) Uniform Color Code.
  6. Wire Tape: 1-inch minimum width polyethylene tape intended for direct burial service.
  7. Wire Connections: Lockable type specifically manufactured for use in underground tracer wire installation and be dielectric silicon filled to seal out moisture and prevent corrosion being SnakeBite Part #SCB-01-SR, or approved equal.
    - a. Non-locking, friction fit, twist-on, or taped connectors are not acceptable.
    - b. Twisting of copper wiring is not acceptable.
  8. Tracer wire for directional drilling, pipe bursting, or boring shall be Copperhead SoloShot 1045, #10 AWG high strength copper-clad steel conductor with 45 mil HDPE insulation rated for direct bury use and 2,032 lb minimum break load or Architect/Engineer approved equal.

## 2.05 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. 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 and identify utilities that remain and protect from damage.
- C. Notify utility company to remove and/or relocate utilities in conflict.
- D. The Contractor shall use extreme caution to avoid a conflict, contact, or damage to overhead utilities such as power lines, streetlights, telephone lines, television lines, poles or other appurtenances during the course of construction of the Project.
- E. Protect survey control points/bench marks, structures, fences, site concrete, and paving from excavating equipment and vehicular traffic.
- F. Protect landscaping, ornamental objects, other features, and other features to remain.

- G. All construction zones shall be cleared and grubbed of all stumps, logs, trees, roots, brush, weeds, tree trimmings, and other vegetation or debris per 311000 - Site Clearing, as may be required for the proper conduct and execution of the Work.
- H. Existing pavement and concrete shall be saw cut in a straight line to make a neat joint with no broken corners or ragged edges and then replaced according to these Specifications.
- I. Adequate barricades, construction signs, warning lights, and guards shall be placed and maintained during the progress of the construction work and until it is safe to resume use of the trench area. Rules and regulations of the local authorities respecting safety provisions shall be observed.
- J. Grading shall be done as necessary to prevent surface water from flowing into excavations, and any water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in trenches until after the pipe has been placed, bedded, and backfilled. Any pipe having its alignment or grade changed by floating in a flooded trench shall be reinstalled at no additional cost to the Owner.
- K. Any equipment operating on tracks which is used on asphalt paved or bituminous surfaced areas shall be equipped with suitable pads to prevent damage to the surface. All such surfaces which are damaged during construction shall be restored to their original condition by the Contractor at their expense. Any mud or soil tracked onto existing roads shall be removed.

### 3.03 TRENCHING

- A. All excavation, trenching, shoring, and the like, under this contract shall be performed in a manner that meets with the Occupational Safety and Health Standards, 29 CFR 1926 - Excavations, as published by the Occupational Safety and Health Administration. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in the trenching operation.
- B. Excavation shall be open cut, unless shown otherwise on the plans.
- C. Blasting will not be permitted.
- D. When crossing gravel surfaced roads/streets, cultivated areas, or prospective cultivated areas, the Contractor shall strip the surfacing and/or topsoil. This surfacing and/or topsoil shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose.
- E. Notify Architect/Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- F. Cut trenches wide enough to provide adequate working room for workers to install and join the pipe, and to place and compact the bedding and backfill materials in the specified manner.
- G. Trench depth shall be as required for the invert grade or pipe bury depth shown on plans. Care shall be taken not to excavate below the required depth. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings.
- H. Excavations for manholes, hydrants, structures, and other appurtenances shall be sufficient to leave clearance adequate for proper compaction efforts on all sides. The depth, provisions for removing water, and other applicable portions of these specifications shall apply to excavation for appurtenances.
- I. Hand trim excavations and remove loose matter.
- J. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

- K. Soft or unstable material which will not support a minimum of 300 pounds per square foot shall be removed and replaced with Imported Pipe Foundation Material compacted to the pipe foundation grade (original trench bottom).
- L. During excavation, materials suitable for backfilling shall be piled in an orderly manner a distance of at least 2 feet from the banks of the trench to avoid overloading and to prevent slides or cave-ins. Excavated material shall be stockpiled to permit access to existing buildings, fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances. Surface drainage of adjoining areas shall be unobstructed.
- M. Remove excess excavated material from site, or as directed by the Architect/Engineer.
- N. Provide temporary means and methods, as required, to remove all water from trenching. The Contractor shall not allow water resulting from dewatering activities to be discharged or disposed of in such a manner as to flood existing landscaped areas, graveled areas, structures, or to cause erosion problems. Dewatering activities shall comply with all requirements and regulations of all federal, state, or local agencies that govern the handling of groundwater and/or stormwater.

### 3.04 DEWATERING

- A. The Contractor shall furnish all labor, equipment, and incidentals necessary to dewater the project site during construction. All excavation shall be kept free of water during all construction and the placement of materials. No groundwater or storm water shall be allowed to enter or flow through the water or sanitary sewer lines installed in the project. Groundwater may be discharged into the existing storm drain if approved by the appropriate regulating agency and/or City. The Contractor shall by pumping, dewatering wells, berming, coffer damming, sheet piling, or by other methods or combinations thereof, keep the construction area free from water.
- B. It shall be the Contractor's responsibility to comply with all requirements and regulations of all federal, state, or local agencies that govern the handling of groundwater or stormwater, or other aspects of the work at the construction site or affected areas. The Contractor shall not allow water resulting from dewatering activities to be discharged or disposed of in such a manner as to flood existing landscaped areas, graveled areas or structures, cause erosion problems, or violate Wyoming Water Quality Regulations. The Contractor's dewatering program shall be conducted in such a manner as to avoid damage to existing structures. The Contractor shall be responsible for repairing all structures damaged as a result of the dewatering. No extra payment shall be made to the Contractor for repairing any structures damaged by dewatering.
  - 1. Discharge from dewatering operations shall be in accordance with rules and regulations established by the Wyoming Department of Environmental Quality (DEQ). These activities require coverage under a NPDES permit. The DEQ has issued a general permit for temporary discharge of wastewaters to surface waters of the state associated with: hydrostatic testing of pipes, tanks, or other similar vessels, disinfection of potable water lines, pump tests of water wells, or construction dewatering.
  - 2. In order to request coverage under the general permit for temporary discharges, the Contractor must complete and submit a "Notice of Intent" (NOI) to the DEQ.
  - 3. Effluent associated with construction dewatering. Refer to table:
  - 4.

| PARAMETER | EFFLUENT LIMITATION | FREQUENCY | SAMPLE TYPE                 |
|-----------|---------------------|-----------|-----------------------------|
| Flow, gpm | N/A                 | Daily     | Instantaneous or Continuous |

|                              |                                                                                                                                                                                                                |        |        |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|
| Total Suspended Solids, mg/L | The concentration shall not exceed a monthly average of 30 mg/l, a weekly average of 45 mg/l, or a daily maximum of 90 mg/l                                                                                    | Weekly | Grab   |
| pH, s.u.                     | The pH shall not be less than 6.5 nor more than 9.0 standard units                                                                                                                                             | Daily  | Grab   |
| Oil and Grease               | The concentration shall not exceed 10 mg/l                                                                                                                                                                     | Daily  | Visual |
| Turbidity                    | A discharge to Class 1 water shall not result in a turbidity increase of 10 nephelometric turbidity units (NTUs). A discharge to Class 2 or Class 3 waters shall not result in a turbidity increase of 15 NTUs | Daily  | Grab   |

- C. If the Contractor over excavates and places clean rock in the bottom of the trench for dewatering, a barrier must be placed between this rock and the pipe bedding to prevent the migration of fine soil particles out of the bedding. This barrier shall be a geotextile fabric or polyethylene or polyurethane membrane of sufficient strength to resist damage when placed in this location and be of a material that does not deteriorate over time. The material and method of installation shall be approved by the Architect/Engineer.
- D. Upon completion of the project tasks requiring the dewatering measures specified herein, the Contractor shall remove all such structures and restore all areas disturbed to their original conditions and grade and in accordance with these Specifications. No berms, excavations for dewatering, or similar features shall be allowed to remain at the completion of the restoration. All restoration shall be approved by the Architect/Engineer.

### 3.05 PREPARATION FOR UTILITY PLACEMENT

- A. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

### 3.06 PIPE BEDDING

- A. All Imported Bedding Material shall be placed into the trench, to a minimum depth of 6 inches at any point after leveling, except bell holes shall have a depth of at least 3 inches. Bell holes and the placement of bedding shall provide for the full support of the pipe. Imported Bedding Material deposited in the trench shall be spread, graded, and initially compacted no more than necessary to insure a slightly yielding, uniform, and continuous support for installed pipe at all points between pipe joints.
- B. All Imported Bedding Material above the bottom of the pipe shall be placed to fill any voids adjacent to the pipe, leveled, and thoroughly compacted by tamping, vibration, rodding, or by a combination of these methods. Special effort is required to compact the material under the pipe "haunches", to provide adequate support to the pipe. Placement techniques are to avoid damage to the pipe, coating on pipe and fittings, joint bonds, and corrosion protection materials. Bedding adjacent to and over the pipe is to be placed in layers not to exceed 6 inches, with each layer thoroughly compacted. Bedding adjacent to the pipe is to be placed and compacted on both sides simultaneously. Water settling of bedding is not allowed. All backfill material, equipment used, and the results obtained in placing fill material shall be subjected at all times to the approval of the Architect/Engineer.



- C. For pipes laid to grade, the Contractor shall provide compaction efforts to the material beneath the pipe to assure the installed product meets the tolerances for alignment and grade. Grading of the compacted material beneath the pipe must be such that high points are not created that put stress on or bend the pipe.
  - 1. If Type 1 Imported Bedding Material is used for pipes laid to grade, the material shall be compacted to at least 93 of maximum density and the moisture content must be within 2% of optimum moisture content. Compacted material shall be placed below the pipe and up to the pipe haunches.

### 3.07 BACKFILLING

- A. The Contractor will be required to conduct his work so that trenches will remain open a minimum possible time.
- B. No trench excavating shall begin until approved compaction equipment is at the site where the excavation is to take place. All backfill and compacting shall be completed in all trenching and structural excavations within a maximum distance of 200 feet behind the end of the newly installed pipe and the maximum distance between the newly installed pipe and the excavator shall be 200 feet. For each work group consisting of trench excavator, a pipe laying crew, and a backfilling and compacting crew, the maximum allowable open ditch at any time will be 400 feet.
- C. Certain conditions may necessitate the closing of certain sections of trench, such as prior to daily, weekend, or holiday shutdown.
- D. Fill up to subgrade elevations unless otherwise indicated.
- E. Employ a placement method that does not disturb or damage other work.
- F. Maintain optimum moisture content of fill materials to attain required compaction density.
- G. The backfill above the Imported Bedding Material shall be placed in lifts not to exceed an uncompacted thickness of 12 inches. The backfill may be placed by machine, or other method(s) approved by the Architect/Engineer, which will not impose excessive, concentrated, or unbalanced loads which might result in damage to or displacement of the pipe.
  - 1. Material shall be free of frozen material, snow, and mud.
  - 2. The Contractor shall add water or aerate material as required in placing compacted backfill to bring the material within 2% of optimum moisture content.
  - 3. Excavated soil materials which possess natural moisture in excess of 6% above optimum moisture shall be considered unsuitable for backfill.
  - 4. Backfill around hydrants, valve boxes, manholes, inlet boxes, or similar appurtenances shall be hand compacted.
  - 5. Non-detectable Warning Tape, in accordance with subsection 2.4 of this Section, is to be buried in the backfill of water main and sanitary sewer trenches to a depth of 18 to 24 inches below the finish surface grade shown in the Plans.
- H. Compaction Density Unless Otherwise Specified or Indicated:
  - 1. Under paving, slabs-on-grade, and similar construction: 93 percent of maximum dry density.
  - 2. At unsurfaced areas: 93 percent of maximum dry density.
  - 3. At other locations: 93 percent of maximum dry density.
- I. Reshape and recompact fills subjected to vehicular traffic.

- J. Excess earth from excavations located in open fields and unimproved property shall be distributed directly back over the pipe trench and within the pipeline right-of-way to a maximum depth of 6 inches above the original ground surface elevation, at and across the trench, and sloping uniformly each way therefrom. Material placed shall be carefully finished with a drag, blade machine, or other suitable tools, to a smooth, uniform surface without obstructing drainage at any point.

### 3.08 BEDDING AND FILL AT SPECIFIC LOCATIONS

#### A. Utility Piping

- 1. Imported Bedding Material:
  - a. For pressurized pipelines where minor pipe settlement will not affect performance of the conduit, Type 1 Imported Bedding Material shall be placed from a point 6 inches below the bottom of the pipe to 6 inches above the top of the pipe, and a minimum of one foot on each side of the pipe.
  - b. For gravity flow pipelines where grade of the pipe is critical to performance and minor settlements may be detrimental, Type 2 Imported Foundation Material shall be placed from a point 6 inches below the bottom of the pipe to the spring-line, and a distance of at least one foot on each side of the pipe. Type 1 bedding may be placed from 6 inches below the bottom of the pipe to the spring-line, if material can meet the compaction requirements of this specification. From spring-line to 6 inches above the top of the pipe, Type 1 Imported Bedding Material may be used.
  - c. Contractor will be responsible for locating the source and obtaining the material as well as the excavation, haul, placement and compaction of the Imported Bedding Material (Type 1).
- 2. Imported Pipe Foundation Material: Shall be used below the bedding zone when excavated soil material is deemed as unsuitable foundation for the bedding and pipe.
  - a. It is not intended to assist with the dewatering process.
  - b. Contractor shall be responsible for locating the source, excavation, haul, placement, and compaction of the Imported Pipe Foundation Material.

#### B. Culverts:

- 1. Bedding: Use general fill.
- 2. Cover with general fill.
- 3. Fill up to subgrade elevation.
- 4. Compact in maximum 8 inch lifts to 93 percent of maximum dry density.

### 3.09 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D6938.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor") or AASHTO T 180.
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: Testing shall be every 2 feet of vertical depth, extending from 12 inches above the pipe bedding to 1 foot below subgrade.
  - 1. Trenches: 1 test location per 150 lineal feet of trench.
  - 2. Manholes and Valve Boxes: All manholes and valve boxes located within paved or hardscape areas shall be tested. All of the remaining manholes and valve boxes shown in the Plans shall be tested.

### 3.10 DRY UTILITY TRENCHING

- A. Excavate, backfill, and compact "dry utility trenches" in order for dry utility companies identified in the Contract Documents to install and/or relocate their equipment underground. The trench for the dry utilities shall be installed at the locations shown in the Plans. The work shall include furnishing and installing PVC Schedule 80 conduit, sized as called out in the Plans, which shall then be used by the appropriate dry utility company for their wire or cable.

### 3.11 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. All excess excavated materials shall be legally disposed of away from the site of the work by the Contractor, including but not limited to:
  - 1. Broken concrete, asphalt, and other coarse debris resulting from pavement or sidewalk removal.
  - 2. Excavated rock in excess of the amount permitted to be and actually installed in trench backfill.
  - 3. Junk, debris, and other similar waste materials encountered in excavation work.

### 3.12 SURFACE RESTORATION

- A. Grassy Areas: Replace topsoil, prepare seedbed, and reseed in accordance with Section 329200 - Turf and Grasses. Prior to seeding, surface is to be smoothed to eliminate wheel ruts, ridges, and low areas.
- B. Gravel Roadways and Parking Areas: Restore to the preexisting condition with no less than 8 inches of crushed base. All materials, placement, and compaction shall be in accordance with Section 321123 - Aggregate Base Courses.
- C. Asphalt Roadways and Parking Areas: Restore to preexisting conditions with no less than 4 inches of asphalt pavement atop 8 inches of crushed base in all travelled areas or as called out in the Plans. All materials, placement, and compaction shall be in accordance with Section 321123 - Aggregate Base Courses and Section 321216 - Asphalt Paving.
- D. Concrete Pavement Areas: Restore to preexisting conditions with no less than 6 inches of asphalt pavement atop 8 inches of crushed base in all travelled areas or as called out in the Plans. All materials, placement, and compaction shall be in accordance with Section 321123 - Aggregate Base Courses and Section 321313 - Concrete Paving.
- E. Concrete Site Work: Restore concrete sidewalks, curb and gutter, valley pans, and other site concrete to preexisting conditions as called out in the Plans.

### 3.13 CLEANING

- A. As work progresses, that portion of the work completed shall be cleared of debris and brought to the finished grade. Upon completion of the work, the entire site shall be cleared of all debris and ground surfaces shall be finished to smooth, uniform slopes and shall present a neat and workmanlike appearance. All rocks brought to the ground surface by excavation or backfilling operations shall be removed.
- B. At all times during construction, the Contractor shall be responsible for dust control as directed by the Architect/Engineer.
- C. Remove unused stockpiled materials and leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- D. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 312316.13

## SECTION 312316 - EXCAVATION

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Excavating for building foundations, slabs on grade, site concrete, paving, site structures, and general earthwork.
- B. Temporary excavation support and protection systems.

#### 1.02 RELATED REQUIREMENTS

- A. Document: Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025) Geotechnical report; bore hole locations and findings of subsurface materials.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 015713 - Temporary Erosion and Sediment Control
- D. Section 311000 - Site Clearing
- E. Section 312201 - Grading
- F. Section 312316.13 - Trenching
- G. Section 312323 - Fill
- H. Section 313700 - Riprap.
- I. Section 330200 - Underground Utilities

#### 1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction.

#### 1.04 SUBMITTALS

- A. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

#### 1.05 QUALITY ASSURANCE

- A. Perform work in accordance with the referenced geotechnical engineering report.
- B. Temporary Support and Excavation Protection Plan:
  - 1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
  - 2. Include drawings and calculations for bracing and shoring.
  - 3. Bracing and shoring design to meet requirements of OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
- C. Designer Qualifications: For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State of Wyoming.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Bedding and Fill to Correct Over-Excavation:
  - 1. Perform work in accordance with the referenced geotechnical engineering report.
  - 2. See Section 312323 - Fill for bedding and corrective fill materials at general excavations.
  - 3. See Section 312316.13 - Trenching for bedding and corrective fill materials at utility trenches.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that survey benchmark and intended elevations for the work are as indicated.
- B. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by Architect/Engineer. If the proposed excavation extends more than 1 foot into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

### 3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 312201 - Grading for topsoil removal.
- C. Locate and identify utilities that remain and protect from damage.
- D. Protect survey control points/benchmarks, structures, fences, site concrete, and paving from excavation equipment and vehicular traffic.
- E. Protect landscaping, ornamental objects, and other features to remain.
- F. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect/Engineer.

### 3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
  - 1. Depending upon excavation depth, time that excavation is open, soil classification, configuration and slope of excavation sidewall, design and provide an excavation support and protection system that meets the requirements of 29 CFR 1926, Subpart P:
    - a. Sloping and benching systems.
    - b. Support systems, shield systems, and other protective systems.

### 3.04 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
  - 1. Excavate to the specified elevations.

2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
  3. See Section 312316.13 - Trenching for required excavation clearances for pipes in utility trenches.
  4. Hand trim excavations. Remove loose matter.
- B. Notify Architect/Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect/Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

### 3.05 SUBGRADE PREPARATION

- A. See Section 312201 - Grading for subgrade preparation at general excavations.
- B. See Section 312316.13 - Trenching for subgrade preparation at utility trenches.

### 3.06 FILLING AND BACKFILLING

- A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.
- B. See Section 312323 - Fill for fill, backfill, and compaction requirements at general excavations.
- C. See Section 312316.13 - Trenching for fill, backfill, and compaction requirements at utility trenches.
- D. See Section 312201 - Grading for rough and final grading and topsoil replacement requirements.

### 3.07 REPAIR

- A. Correct areas that are over excavated and load bearing surfaces that are disturbed.

### 3.08 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Provide for visual inspection of load bearing excavated surfaces by Architect/Engineer before placement of foundations.

### 3.09 CLEANING

- A. Stockpile excavated material to be reused in a designated area on site in accordance with Section 312201 - Grading.
- B. Remove excavated material that is unsuitable for reuse from site.
- C. Remove excess excavated material from site.

### 3.10 PROTECTION

- A. Divert surface flow from rains or water discharges from the excavation.
- B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory and undisturbed condition.
- D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION 312316



## SECTION 126100 - FIXED AUDIENCE SEATING

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.02 SUMMARY

- A. Section includes fixed, chair-type seating with the following:
  - 1. Standard mounting.
  - 2. Upholstered chairs or Molded-plastic chairs with upholstered inserts.
  - 3. Aisle lighting lamps integral to fixed seating.

#### 1.03 DEFINITIONS

- A. Pan: An exposed, supporting seat bottom made of steel.
- B. Shell: An exposed, supporting seat bottom or back made of materials other than steel.

#### 1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of components, and finishes for fixed audience seating.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Seating Layout: Show seating layout, aisle widths, aisle-end alignment or stepping, row-lettering and chair-numbering scheme, chair widths, and chair spacing in each row.
  - 3. Accessories: Show locations and features of accessories, including accessibility provisions.
- C. Samples for Initial Selection: For each type of exposed color, finish, texture, and pattern indicated.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
  - 1. Chair Unit: Full-size unit of each type.
  - 2. Molded Plastic: Manufacturer's standard-size unit, not less than 3 inches square.
  - 3. Baked-on Coating Finishes: Manufacturer's standard-size unit, not less than 3 inches square.

4. Upholstery Fabric: Full width by 36-inch-long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.
5. Row-Letter and Chair-Number Plates: Full-size units with letters and numbers marked.
6. Aisle Lighting: Full-size unit.
7. Exposed Fasteners: Full-size units of each type.
8. Full-size samples of chair units, if approved, will be returned to Contractor for use in Project.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fixed audience seating.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

#### 1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fixed audience seating to include in operation and maintenance manuals.
  1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Maintenance of self-rising seat mechanisms, folding armrests, and other operating components.
    - b. Adjustment of self-rising seat mechanisms to align seats.
    - c. Methods for maintaining upholstery fabric.
    - d. Precautions for cleaning materials and methods that could be detrimental to seating finishes and performance.

#### 1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Chair Seats and Backs: 5 percent of quantity installed for each type and size of chair seat and back.
  2. Upholstered, Slip-on Cushions: 5 percent of quantity installed for each type and size of cushion.
  3. Armrests: 5 percent of quantity installed for each type of armrest.
  4. Chair Seat Hinges: 5 percent of quantity installed.
  5. Seat Numbering Plates: 5 percent of quantity installed, complete with hardware required for installation.
  6. Aisle-Lighting Fixture Bulbs: 5 percent of quantity installed.

## 1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fixed audience seating that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including standards, beams, and pedestals.
    - b. Faulty operation of self-rising seat mechanism.
    - c. Faulty operation of electrical components.
    - d. Wear and deterioration of fabric and stitching beyond normal use.
    - e. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - 2. Warranty Periods: As follows, from date of Substantial Completion.
    - a. Structural: Five years.
    - b. Operating Mechanisms: Five years.
    - c. Electrical Components: Three years.
    - d. Plastic, Wood, and Paint Components: Five years.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Source Limitations: Obtain each type of seating required, including accessories and mounting components, from single source from single manufacturer.
  - 1. Upholstery Fabric: Obtain fabric of a single dye lot for each color and pattern of fabric required.

### 2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics of Upholstered Chairs:
  - 1. Fabric and Padding:
    - a. Fabric: Class 1 according to DOC CS 191 or 16 CFR 1610, tested according to California Technical Bulletin 117-2000.
    - b. Padding: Comply with California Technical Bulletin 117-2000.
  - 2. Upholstery Assembly: Assembly shall comply with component-testing requirements of California Technical Bulletin 117-2013.
- B. Strength and Durability Performance: Chairs and components shall pass testing according to BIFMA X5.4.

### 2.03 FIXED AUDIENCE SEATING

- A. Description: Assembly-space seating in permanent arrangement as indicated on Drawings.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hussey Seating Company; Quattro Traditional or a comparable product by one of the following:
    - a. American Seating Company.
    - b. Irwin Seating Company.
    - c. Davis Furniture Company.

- B. Chair Mounting Standards: Floor attached of the following material:
  - 1. Steel: One-piece, heavy-tube or reinforced sheet with welded mounting plate and welded connections for seat pivots, backs, armrests, and end panels.
- C. End Panels: Hardwood-veneer plywood.
  - 1. Style: Tapered with rounded corners.
  - 2. Veneer Species and Finish: As selected by Architect from manufacturer's full range.
  - 3. End panels shall be factory prepared for aisle lighting.
- D. Fabric Upholstered Chairs:
  - 1. Back:
    - a. Padding Thickness: 2 inches.
    - b. Outer Back Surface: Molded plastic, with concealed fasteners.
    - c. Top Corners: Square.
  - 2. Seat: One part, fully upholstered construction and as follows:
    - a. Top Padding Thickness: Minimum 3 inches at front and rear edges.
    - b. Seat Bottom: Molded-plastic shell.
- E. Chair Width: Vary chair widths to optimize sightlines and row lengths from center to center of armrests.
- F. Back Height: 33 inches high from the floor.
- G. Back Pitch: Fixed.
  - 1. Back Angle: Angle for optimum viewing comfort.
- H. Chair Seat Hinges: Self-lubricating, with noiseless self-rising seat mechanism passing ASTM F 851, positive internal stops cushioned with rubber or neoprene, and requiring no maintenance.
  - 1. Self-Rising Seat Mechanism: Spring actuated, full fold.
- I. Armrests: Solid hardwood with rounded edges and concealed mounting.
  - 1. Folding Armrests: Equip seating with folding aisle armrests where indicated for accessible companion seating.
- J. Aisle-Lighting Fixtures: Round full cut-off fixtures.
  - 1. Basis-of-Specification: Beacon Seat Lighting by Tivoli.
  - 2. Bulb: LED.
  - 3. Power: 12V.
  - 4. Performance Requirement: Aisle lighting shall provide 0.2 fc, minimum across aisle as required by Code.
  - 5. Exposed Finish: As selected by Architect from manufacturer's full range.
  - 6. Lens Color: As selected by Architect from manufacturer's full range.
  - 7. Transformers shall be supplied by lighting manufacturer as part of assembly and located as indicated on Drawings or, if not indicated, as directed by Architect / Engineer of Record for Project.
- K. Accessible Seating:
  - 1. Provide removable chairs for each wheelchair space unless otherwise indicated.
  - 2. Provide chairs with folding armrest on aisle side in locations indicated, but not less than 5 percent of aisle seats, dispersed through the audience seating area. Identify these seats with a sign or marker.
- L. Row-Letter and Chair-Number Plates: Manufacturer's standard.
  - 1. Location: Row letter on top of aisle armrest and chair number on front edge of seat.
  - 2. Attachment: Minimum of two mechanical fasteners.

- M. Accessibility-Logo Plates: Manufacturer's standard.
  - 1. Location: Top of armrest.
  - 2. Attachment: Minimum of two mechanical fasteners.

## 2.04 MATERIALS AND FINISHES

- A. Concealed Plywood: HPVA HP-1 hardwood plywood or DOC PS 1 softwood plywood as standard with manufacturer.
- B. Hardwood Lumber: Species as indicated on Drawings selected to be free of visible defects.
  - 1. Stain and Finish: As indicated on Drawings.
- C. Molded Plastic: High-density polyethylene or polypropylene, blow or injection molded, with surface that is mar and dent resistant.
  - 1. Provide with UV inhibitors to retard fading.
  - 2. Color and Texture: As indicated on Drawings.
- D. Fabric: Manufacturer's standard 100 percent polyolefin.
  - 1. Weight: Manufacturer's standard, meeting performance requirements.
  - 2. Color and Pattern: As indicated on Drawings.
- E. Upholstery Padding: Flexible, cellular, molded or slab polyurethane foam.
  - 1. Pounding-Fatigue Performance: Grade AP (heavy-duty use) for seats and Grade BP (normal duty use) for backs; according to ASTM D 3453.
- F. Metal Finish: Finish exposed metal parts with manufacturer's standard minimum 1.5-mil-thick, polyester baked-on powder coating.
  - 1. Color: As indicated on Drawings.

## 2.05 FABRICATION

- A. Floor Attachments: Fabricate to conform to floor slope so that standards and pedestals are plumb and chairs are maintained at same angular relationship to vertical throughout Project.
- B. Upholstery: Fabricate fabric-covered cushions with molded padding beneath fabric and with fabric covering free of welts, creases, stretch lines, and wrinkles. For each upholstered component, install pile and pattern run in a consistent direction.
- C. Upholstered Chairs: Fabricate as follows:
  - 1. Two-Part, Molded-Plastic Seats: Upper part, an upholstered cushion with formed padding over a five-ply plywood panel with fabric cover conforming to shape of cushion to conceal inner seat structure and hinge mechanism. Lower part, a molded-plastic shell.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine floors, risers, and other adjacent work and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Install seating in locations indicated and fasten to substrates according to manufacturer's written installation instructions.
  - 1. Install seating with each chair capable of complying with performance requirements without failure or other conditions that might impair the chair's usefulness.
  - 2. Install standards and pedestals plumb.
  - 3. Install seating so moving components operate smoothly and quietly.
- B. Install seating with end standards aligned or stepped as indicated from first to last row and with backs and seats varied in width and spacing to optimize sightlines, maintaining minimum seat count as indicated on Drawings.
- C. Where seating is indicated in curved rows, install seating at a constant radius unless otherwise indicated.
- D. Install wiring conductors and cables concealed in components of seating and accessible for servicing.
  - 1. Connect electrical service at junction-box locations according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Inspect components, assemblies, and equipment, including connections, to verify proper, complete, and sturdy installation according to manufacturer's written instructions and product specifications.
  - 2. Verify that self-rising seats return to uniform at-rest, raised position.
  - 3. Verify lighting levels and performance of aisle-lighting.
- B. Fixed audience seating will be considered defective if it does not pass tests and inspections.

### 3.04 ADJUSTING

- A. Adjust chair backs so that they are at required angles and aligned with each other in uniform rows.
- B. Adjust hardware and moving parts to function smoothly so they operate easily. Lubricate bearings and sliding parts as recommended in writing by manufacturer.
- C. Adjust self-rising seat mechanisms so seats in each row are aligned when in upright position.
- D. Repair minor abrasions and imperfections in finishes with coating that matches factory-applied finish.
- E. Replace damaged and malfunctioning components that cannot be acceptably repaired.
- F. Replace upholstery fabric damaged during installation or work of other trades.

END OF SECTION 126100

## SECTION 312323 - FILL

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

#### 1.02 RELATED REQUIREMENTS

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report; bore hole locations, findings of subsurface materials, and recommendations.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 015713 - Temporary Erosion and Sediment Control
- D. Section 033100 - Site Concrete Work
- E. Section 312201 - Grading
- F. Section 312316 - Excavation
- G. Section 312316.13 - Trenching
- H. Section 312500 - Engineering Fabric
- I. Section 321123 - Aggregate Base Courses
- J. Section 321216 - Asphalt Paving
- K. Section 321313 - Concrete Paving

#### 1.03 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: Indicated on drawings.

#### 1.04 REFERENCE STANDARDS

- A. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
- C. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- D. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- E. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

## 1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.
- E. Testing Agency Qualification Statement.

## 1.06 QUALITY ASSURANCE

- A. Any discrepancies between the referenced geotechnical report and this section of the specifications shall follow the recommendations of the geotechnical report unless a written amendment is provided to the Contractor and the Architect/Engineer by the geotechnical engineer.

## 1.07 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 indicated.
  - 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: Native site soil..
  - 1. Graded.
  - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
- B. Structural Fill: Imported borrow.
  - 1. Grading W
    - a. Graded in accordance with ASTM C136/C136M, with the following limits:
      - 1) 1-1/2 inch sieve: 100 percent passing.
      - 2) 1 inch sieve: 90 to 100 percent passing.
      - 3) 1/2 inch sieve: 60 to 85 percent passing.
      - 4) No. 4 sieve: 35 to 60 percent passing.
      - 5) No. 8 sieve: 33 to 53 percent passing.
      - 6) No. 200 sieve: 3 to 12 percent passing.
    - b. Liquid Limit (LL): < 25.
    - c. Plasticity Index (PI): < 3.
  - 2. Envelope A
    - a. Graded in accordance with ASTM C136/C136M, with the following limits:
      - 1) 1-1/2 inch sieve: 100 percent passing.
      - 2) No. 4 sieve: 50 to 100 percent passing.
      - 3) No. 8 sieve: 30 to 90 percent passing.
      - 4) No. 30 sieve: 15 to 75 percent passing.
      - 5) No. 50 sieve: 10 to 60 percent passing.



- 6) No. 200 sieve: 0 to 20 percent passing.
    - b. Liquid Limit (LL): < 40.
    - c. Plasticity Index (PI): < 15.
  - 3. On site material
    - a. Refer to the referenced geotechnical engineering report.
- C. Topsoil: See Section 312201 - Grading.

## 2.02 ACCESSORIES

## 2.03 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Owner will engage soil testing/inspection service acceptable to the Architect/Engineer for quality testing during construction per Section 014000 - Quality Requirements.
- C. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- D. If tests indicate materials do not meet specified requirements, change material and retest.
- E. 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.
- B. Identify required lines, levels, contours, and datum locations.
- C. See Section 312201 - Grading for additional requirements.
- D. Verify subdrainage, damp proofing, or water proofing installation has been inspected.
- E. Verify structural ability of unsupported walls to support imposed loads by the fill.
- F. Verify areas to be filled are not compromised with surface or ground water.

### 3.02 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 12 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with material as directed by geotechnical engineer.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

### 3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.

- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. When embankments are to be placed on a hillside, or where new fill is to be placed against existing embankment, the slope of the original hillside, or old fill respectively, shall be benched or stepped by cutting into it horizontally, for a minimum distance of 36 inches to provide for secure bonding of the embankment while it is being brought up in layers. Each bench shall be cut as close to the one below as the slope of the ground will permit. Material thus cut out of the benches shall be incorporated into the new fill.
- F. Embankment placed adjacent to structures shall be brought up in equal layers on all sides to prevent distortion of any of these parts. If it is necessary to deposit embankment on only one side of abutments, wing walls, piers, or culvert headwalls, compaction shall be accomplished without causing overturning of or excessive pressure against the structure. Areas inaccessible to tamping rollers or power rollers shall be compacted by hand or mechanical tampers or other means until the density conforms to adjacent embankment, compacted in accordance with these specifications.
- G. Embankment material shall be placed in uniform approximate horizontal layers not exceeding 8 inches in loose thickness, for the material compacted by heavy compaction equipment, and not more than 4 inches in loose thickness for material compacted by hand-operated tampers, for the entire width of the embankment and around all appurtenances. Each layer of embankment shall be completed, leveled and compacted to 93 percent of maximum dry density before the succeeding layer is placed.
- H. Embankment which has been subjected to freezing shall be refinished to grade, cross-section and compaction requirements after the frost is out of the ground and the embankment is in suitable condition of work.
- I. Maintain optimum moisture content of fill materials to attain required compaction density.
- J. Correct areas that are over excavated.
- K. Reshape and recompact fills subjected to vehicular traffic.
- L. Maintain temporary means and methods, as required, to remove all water while fill is being placed. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

#### 3.04 FILL AT SPECIFIC LOCATIONS

- A. Structural Fill at locations identified by geotechnical engineer or indicated on the construction plans.
  - 1. Maximum depth per lift: 8 inches, compacted.
  - 2. Compact to minimum 93 percent of maximum dry density.
- B. At Foundation Walls and Footings:
  - 1. Use material referenced in the geotechnical engineering report.
  - 2. Fill up to subgrade elevation.
  - 3. Maximum depth per lift: 6 inches, compacted.
  - 4. Compact each lift to 93 % of maximum dry density.
  - 5. Do not backfill against unsupported foundation walls.
  - 6. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.

- C. At Non-structural fill areas (Any area under non-paved or structure areas as indicated by the geotechnical engineer or indicated on the construction plans):
  - 1. Use Native Site Soils.
  - 2. Fill up to 6 inches below finish grade elevations.
  - 3. Maximum depth per lift: 12 inches, compacted to 90 percent of maximum dry density.
  - 4. See Section 312201 for topsoil placement.
- D. Under Pavement, Site Concrete Areas, Slbs, Athletic Field, and Track Surfaces:
  - 1. Compact subsoil to 93% of its maximum dry density before placing fill.
  - 2. Use material referenced in the geotechnical engineering report.
  - 3. Fill up to subgrade elevation.
  - 4. Maximum depth per lift 8 inches
  - 5. Compact to 93% of maximum dry density.
  - 6. See Section 321123 - Aggregate Base Courses for aggregate base course placed over fill.

### 3.05 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Filling Hardscape Area (concrete, pavement, etc.): Plus or minus 1/2 inch from required elevations.

### 3.06 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. See Section 312201 - Grading for compaction density testing

### 3.07 CLEANING

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

END OF SECTION 312323

## SECTION 312500 - ENGINEERING FABRIC

### PART 1 - GENERAL

#### 1.01 SUMMARY:

- A. This Section covers materials and work associated with providing geosynthetic engineering fabric for stabilization. The fabrics covered in this section shall be a woven or nonwoven fabric consisting only of long chain polymeric filaments or yarns, such as polyethylene, polyester, polyamide, or polyvinylidene-chloride, formed into a stable network so that the filaments or yarns retain their relative positions to each other.

#### 1.02 RELATED REQUIREMENTS

- A. Document: Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025) Geotechnical report; bore hole locations and findings of subsurface materials.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 033100 - Site Concrete Work
- D. Section 313700 - Riprap
- E. Section 312323 - Fill
- F. Section 321123 - Aggregate Base Courses
- G. Section 321216 - Asphalt Paving
- H. Section 321313 - Concrete Paving

#### 1.03 REFERENCE STANDARDS

- A. AATCC Test Method 30 - Antifungal Activity, Assessment on Textile Materials: Mildew and Rot Resistance of Textile Materials.
- B. ASTM D4354 - Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing.
- C. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus.
- D. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- E. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- F. ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
- G. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- H. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

- I. ASTM D4884/D4884M - Standard Test Method for Strength of Sewn or Bonded Seams of Geotextiles.
  - J. ASTM D6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe.
  - K. WYDOT Standard Specifications for Road and bridge Construction - Wyoming Department of Transportation Standard Specifications for Road and Bridge Construction.
- 1.04 SUBMITTALS:
- A. Submittals are required for all materials and shall be in accordance with these Specifications.
- 1.05 QUALITY ASSURANCE
- A. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions. All test methods shall be in accordance with latest ASTM procedures.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. In the manufacture of woven or non-woven geotextiles and threads used in joining geotextiles by sewing, use fibers consisting of long-chain synthetic polymers, composed of at least 95% by weight, of polyolefins or polyesters. Form fibers into a stable network while retaining their dimensional stability relative to each other, including selvages. Provide both in accordance with the specified use requirements as specified in this Specification.
  - 1. Property values listed within in the following section, with the exception of apparent opening size, represent minimum average roll values (MARV) in the weakest principle direction (i.e. average test results of any roll in a lot sampled for conformance or quality assurance testing to meet or exceed the minimum values provided herein).
  - 2. Non-stabilized or low susceptible geotextiles are not to be exposed to ultraviolet radiation for more than five calendar days.
  - 3. Drainage & Filtration Geotextile Fabric:
    - a. Equivalent or Apparent Opening Size: 40-70 inches when tested in accordance with ASTM D4751.
    - b. Hydraulic Flow Rate: 50 gal/min/sq ft per second minimum when tested in accordance with ASTM D4491/D4491M.
    - c. Tensile Strength: 80 lbs minimum when tested in accordance with ASTM D4632/D4632M.
    - d. Elongation at Failure: 50% minimum when tested in accordance with ASTM D4632/D4632M.
    - e. Trap Tear Strength: 25 lbs minimum when tested in accordance with ASTM D4533/D4533M.
    - f. Puncture Strength: 25 lbs minimum when tested in accordance with ASTM D6241.
    - g. Seam Strength: 40 lbs/in minimum when tested in accordance with ASTM D4884/D4884M
    - h. Seam Efficiency: 90% minimum when tested in accordance with ASTM D4632/D4632M.
    - i. Ultraviolet Resistance: Minimum 50% strength retention after 500 hours of exposure when tested in accordance with ASTM D4355/D4355M.

- j. Mildew Rot Resistance: Minimum 100% when tested in accordance with AATCC Test Method 30.
- 4. Erosion Control Geotextile Fabric:
  - a. Equivalent or Apparent Opening Size: 40-100 inches when tested in accordance with ASTM D4751.
  - b. Permittivity: 1.0 per second minimum when tested in accordance with ASTM D4491/D4491M.
  - c. Grab Tensile Strength: 200 lbs minimum when tested in accordance with ASTM D4632/D4632M.
  - d. Elongation at Failure: 15% minimum when tested in accordance with ASTM D4632/D4632M.
  - e. Trap Tear Strength: 50 lbs minimum when tested in accordance with ASTM D4533/D4533M.
  - f. Puncture Strength: 70 lbs minimum when tested in accordance with ASTM D6241.
  - g. Seam Strength: 180 lbs/in minimum when tested in accordance with ASTM D4884/D4884M
  - h. Seam Efficiency: 90% minimum when tested in accordance with ASTM D4632/D4632M.
  - i. Ultraviolet Resistance: Minimum 70% strength retention after 500 hours of exposure when tested in accordance with ASTM D4355/D4355M.
  - j. Mildew Rot Resistance: Minimum 100% when tested in accordance with AATCC Test Method 30.
- 5. Silt Fence Geotextile Fabric:
  - a. Equivalent or Apparent Opening Size: 20-50 inches when tested in accordance with ASTM D4751.
  - b. Permittivity: 0.05 per second minimum when tested in accordance with ASTM D4491/D4491M.
  - c. Grab Tensile Strength: 100 lbs minimum when tested in accordance with ASTM D4632/D4632M.
  - d. Elongation at Failure: 15% minimum when tested in accordance with ASTM D4632/D4632M.
  - e. Trap Tear Strength: 50 lbs minimum when tested in accordance with ASTM D4533/D4533M.
  - f. Puncture Strength: 50 lbs minimum when tested in accordance with ASTM D6241.
  - g. Seam Efficiency: 90% minimum when tested in accordance with ASTM D4632/D4632M.
  - h. Ultraviolet Resistance: Minimum 80% strength retention after 500 hours of exposure when tested in accordance with ASTM D4355/D4355M.
- 6. Separation & Stabilization (Non-Woven)
  - a. Equivalent or Apparent Opening Size: 30-70 inches when tested in accordance with ASTM D4751.
  - b. Permittivity: 1.0 per second minimum when tested in accordance with ASTM D4491/D4491M.
  - c. Grab Tensile Strength: 180 lbs minimum when tested in accordance with ASTM D4632/D4632M.
  - d. Elongation at Failure: 15% minimum when tested in accordance with ASTM D4632/D4632M.
  - e. Trap Tear Strength: 70 lbs minimum when tested in accordance with ASTM D4533/D4533M .
  - f. Puncture Strength: 70 lbs minimum when tested in accordance with ASTM D6241.
  - g. Seam Efficiency: 90% minimum when tested in accordance with ASTM D4632/D4632M.
  - h. Ultraviolet Resistance: Minimum 50% strength retention after 500 hours of exposure when tested in accordance with ASTM D4355/D4355M.

7. Subgrade Reinforcement Geotextile Fabric (Woven):
  - a. Equivalent or Apparent Opening Size: 30-50 inches when tested in accordance with ASTM D4751.
  - b. Permittivity: 0.20 per second minimum when tested in accordance with ASTM D4491/D4491M.
  - c. Ultimate Wide Width Tensile Strength: 3200 lbs minimum when tested in accordance with ASTM D4595
  - d. Wide Width Tensile Strength at 5% strain: 1300 lbs minimum when tested in accordance with ASTM D4595.
  - e. Grab Tensile Strength: 320 lbs minimum when tested in accordance with ASTM D4632/D4632M.
  - f. Elongation at Failure: 10% minimum when tested in accordance with ASTM D4632/D4632M.
  - g. Trap Tear Strength: 112 lbs minimum when tested in accordance with ASTM D4533/D4533M .
  - h. Puncture Strength: 618 lbs minimum when tested in accordance with ASTM D6241.
  - i. Seam Efficiency: 90% minimum when tested in accordance with ASTM D4632/D4632M.
  - j. Ultraviolet Resistance: Minimum 50% strength retention after 500 hours of exposure when tested in accordance with ASTM D4355/D4355M.
- B. Engineering fabric installed beneath aggregate base courses shall meet the minimum performance and strength requirements listed for Separation and Stabilization as shown during its service life. Engineering fabric beneath crushed aggregate base course shall be Mirafi HP270, or approved by the geotechnical engineer.
- C. Engineering fabric installed beneath riprap shall meet the minimum performance and strength requirements listed for Subgrade Reinforcement as shown during its service life. Engineering fabric beneath crushed aggregate base course shall be Mirafi RS380i, or approved equal.

## PART 3 - EXECUTION

### 3.01 PACKAGING AND ON-SITE STORAGE

- A. Engineering fabric shall be uniformly rolled onto a cardboard core and shall be wrapped in plastic to protect the material from moisture and damage during shipment. Protective wrapping shall be left on the fabric until installation. The product must not be allowed to get wet prior to installation to prevent weakening of the cardboard core. Rolls shall be externally tagged for easy field identification. External tagging shall include the following:
  1. Name of Manufacturer
  2. Product Type
  3. Product Grade
  4. Lot Number
  5. Physical Dimensions

### 3.02 EXAMINATION

- A. Verify that survey benchmarks and intended elevations for the Work are as indicated.
- B. Identify required lines, levels, contours, and datum locations.
- C. Verify areas to be filled are not compromised with surface or ground water.

### 3.03 SURFACE PREPARATION

- A. The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the drawings. It shall be reasonably smooth and free of loose rock and clods, holes, depressions, projections, muddy conditions, and standing or flowing water.

#### 3.04 INSTALLATION

- A. Before the geotextile is placed, the soil surface will be reviewed for quality assurance of the design and construction. The geotextile shall be placed on the approved prepared surface at the locations and in accordance with the details shown on the drawings. It shall be unrolled along the placement area and loosely laid, without stretching, in such a manner that it conforms to the surface irregularities when material or gabions are placed on or against it. The geotextile may be folded and overlapped to permit proper placement in designated area(s).
- B. Install materials and systems in accordance with the manufacturer's instructions and approved submittals.
- C. The geotextile shall be joined by overlapping a minimum of 18 inches (unless otherwise specified or required by manufacturer) and secured against the underlying foundation material.
- D. When necessary, securing pins, approved and provided by the geotextile manufacturer, shall be placed along the edge of the panel or roll material to adequately hold it in place during installation. Pins shall be steel or fiberglass formed as a U, L, or T shape or contain "ears" to prevent total penetration through the geotextile. Steel washers shall be provided on all but the U-shaped pins. The upstream or upslope geotextile shall overlap the abutting downslope geotextile. At vertical laps, securing pins shall be inserted through the bottom layers along a line through approximately the mid-point of the overlap. At horizontal laps and across slope laps, securing shall be inserted through the bottom layer only. Securing pins shall be placed along a line about 2 inches in from the edge of the placed geotextile at intervals not to exceed 12 feet unless otherwise specified. Additional pins shall be installed as necessary, and where appropriate to prevent any undue slippage or movement of the geotextile. The use of securing pins will be held to the minimum necessary. Pins are to remain in place unless otherwise specified.
- E. Should the geotextile be torn or punctured, or the overlaps or sewn joint disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or grade distortion, the backfill around the damaged or displaced area shall be removed and restored to the original approved condition. The repair shall consist of a patch of the same type of geotextile being used and overlaying the existing geotextile. When the geotextile seams are required to be sewn, the overlay patch shall extend a minimum of 1 foot beyond the edge of any damaged area and joined by sewing as required for the original geotextile except that the sewing shall be a minimum of 6 inches from the edge of the damaged geotextile. Geotextile panels joined by overlap shall have the patch extend a minimum of 2 feet from the edge of any damaged area.
- F. The geotextile shall not be placed until it can be anchored and protected with the specified covering within 48 hours, or protected from exposure to ultraviolet light. In no case shall material be dropped on uncovered geotextile from a height of more than 3 feet.

#### 3.05 CLEANING

- A. Remove unused and/or exposed engineering fabric.

### END OF SECTION 312500



## SECTION 313700 - RIPRAP

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. The work shall consist of the construction of rock riprap revetments and blankets, including filter or bedding where specified.

#### 1.02 RELATED REQUIREMENTS

- A. Document: Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025) Geotechnical report; bore hole locations and findings of subsurface materials.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 015713 - Temporary Erosion and Sediment Control
- D. Section 312201 - Grading
- E. Section 312323 - Fill
- F. Section 312500 - Engineering Fabric

#### 1.03 REFERENCE STANDARDS

#### 1.04 SUBMITTALS

- A. Submittals are required for all materials and shall be in accordance with these Specifications.
- B. Before rock is delivered from its source, the contractor shall designate the source from which rock material will be obtained and provide information satisfactory to the Architect/Engineer that the material meets design requirements. The Contractor shall provide the Architect/Engineer free access to the source for the purpose of visually inspecting the rock and/or obtaining samples for testing. The size and grading of the rock shall be as specified in the plans.

#### 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 indicated.
  - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
  - 2. Prevent contamination.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Rock Riprap: Shall be dense, sound and free from cracks, seams, and other defects conducive to accelerated weathering. The rock shall be angular to sub-rounded in shape with the greatest dimension not greater than 2 times the least dimension. It shall be free from dirt, clay, sand, rock fines, and other material not meeting the required gradation limits. The rock shall be free of weak laminations and cleavages, and shall be of a quality that will not disintegrate on exposure to water or weathering. Riprap shall meet the following requirements:
1. Specific Gravity (ASTM C97): 2.5
  2. Weight: 155 pounds per cubic foot
  3. Maximum Absorption (ASTM C97): 2%
  4. Maximum Loss, Sulfate Soundness (ASTM C88/C88M): 10%
- B. Unless otherwise specified on the plans riprap gradation shall conform to the specified mix number as follows for rock size:

| : ROCK SIZE (in) |         |          |         |
|------------------|---------|----------|---------|
| Mix Number       | Maximum | Ave. D50 | Minimum |
| 1                | 7       | 4        | 1       |
| 2                | 9       | 6        | 1       |
| 3                | 14      | 9        | 1       |
| 4                | 18      | 12       | 2       |
| 5                | 23      | 15       | 2       |
| 6                | 27      | 18       | 3       |
| 7                | 32      | 21       | 3       |
| 8                | 36      | 24       | 4       |
| 9                | 45      | 30       | 4       |
| 10               | 54      | 36       | 5       |

- C. Filter or Bedding Aggregates: Shall be composed of clean, hard and durable mineral particles free from organic matter, clay balls or other deleterious substances. The size and grading of the filter or bedding shall meet the following gradation requirements:

| Sieve Designation | % by Weight Passing |
|-------------------|---------------------|
| 3"                | 100                 |
| #4                | 20-50               |
| #200              | 0-10                |

- D. Geotextiles: Shall conform to the requirements outlined in Section 312500 - Engineering Fabric.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that survey benchmarks and intended elevations for the Work are as indicated.
- B. Identify required lines, levels, contours, and datum locations.
- C. Verify areas to be filled are not compromised with surface or ground water.

### 3.02 SUBGRADE PREPARATION

- A. The subgrade surface on which the rock riprap, filter, bedding, or geotextile is to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved material and shall be compacted to a density equal to the adjacent existing soil material.
- B. Rock riprap, filter, bedding, or geotextile shall not be placed until the foundation preparation is completed and the subgrade surface has been inspected and approved by the engineer.

### 3.03 EQUIPMENT PLACED ROCK RIPRAP

- A. The rock riprap shall be placed by equipment on the surface and to the depth specified. It shall be installed to the full course thickness in one operation and in such a manner as to avoid serious displacement of the underlying material. The rock for riprap shall be delivered and placed in a manner that ensures the riprap in place is reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact to one another with the smaller rocks and spalls filling the voids between the larger rocks.

### 3.04 HAND PLACED ROCK RIPRAP

- A. The rock riprap shall be placed by hand on the surface and to the depth specified. It shall be securely bedded with the larger rocks firmly in contact to one another without bridging. Spaces between the larger rocks shall be filled with smaller rocks and spalls. Smaller rocks shall not be grouped as a substitute for larger rock.

### 3.05 FILTER OR BEDDING MATERIAL

- A. When the plans specify filter, bedding, or geotextile beneath the rock riprap, the designated material shall be placed on the prepared subgrade surface as specified. Compaction of filter or bedding aggregate shall be as specified on the construction drawings. The final surface of such material shall be finished reasonably smooth and free of mounds, dips, or wind rows.

### 3.06 CONSTRUCTION OPERATIONS

- A. Construction operations shall be done in such a manner that erosion and air and water pollution are minimized.
- B. The Contractor will conduct all work and operations in accordance with proper safety guidelines for the type of construction being performed.

### 3.07 CLEANING

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

END OF SECTION 313700

## SECTION 316613.13 - RAMMED AGGREGATE PIERS

### GENERAL

#### 1.01 SECTION INCLUDES

- A. Shaft excavation; placement and compaction of aggregate.

#### 1.02 REFERENCE STANDARDS

- A. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
- B. ASTM D1143/D1143M - Standard Test Methods for Deep Foundation Elements Under Static Axial Compressive Load; 2020, with Editorial Revision (2024).
- C. ASTM D3689/D3689M - Standard Test Methods for Deep Foundation Elements Under Static Axial Tensile Load; 2022.
- D. ASTM D3966/D3966M - Standard Test Methods for Deep Foundation Elements Under Static Lateral Load; 2022.
- E. ASTM D4945 - Standard Test Method for High-Strain Dynamic Testing of Deep Foundations; 2017.

#### 1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
  - 1. Aggregate
  - 2. Uplift anchors
- C. Shop Drawings: Indicate details and schedule of pier installation sequence.
  - 1. Aggregate Pier Layout Drawings, indicating identification number, location, spacing, diameter, and depth of aggregate piers
- D. Design Data: Submit the following:
  - 1. Detailed design calculations.
  - 2. Description of quality control and field testing program.
  - 3. Drawings and design calculations shall be signed and sealed by Professional Engineer licensed in Wyoming who was responsible for their preparation.
- E. Ground Improvement Quality Assurance plan:
  - 1. Quality control test program and modulus test detail and setup for aggregate pier system.
- F. Pier Load Test Report, including:
  - 1. Location identification.
  - 2. Description of testing equipment.
  - 3. Calibration method and recordings.
  - 4. Installation records.
  - 5. Recorded data.
  - 6. Modulus test: A modulus test shall be performed by the aggregate pier contractor to verify the design assumptions. The aggregate pier contractor shall furnish a description of the installation equipment, installation records, complete test data, analysis of the test data and verification of the design parameter values based on the modulus test results. The report shall be prepared under direction of a Registered Professional Engineer.
  - 7. Data analysis.
  - 8. Recommendation of design loads.
  - 9. Description of subsurface conditions.

10. Pier installation recommendations.
- G. Field Quality Control Submittals: Submit daily.
  1. Pier location.
  2. Volume of aggregate.
  3. Installed pier depth.
  4. Number of lifts.
  5. Description of placement method and forces applied.
  6. Design elevation at top and bottom of pier.
  7. Actual, installed elevation at top and bottom of pier.
  8. Documentation of unusual or unexpected conditions encountered.
  9. Description of aggregate used.
- H. Designer's qualification statement.
- I. Project Record Documents: Record actual locations of piers, pier diameter, and pier length. Accurately record the following on project record documents:
  1. Sizes, lengths, and locations of piers and footing groups.
  2. Sequence of placement.
  3. Final base and top elevations.
  4. Deviation from indicated locations.
  5. Certification that the design modulus value has been achieved within settlement tolerances.

#### 1.04 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
  1. Designer of the work of this section with minimum 5 years of documented experience with a record of successful in-service performance on projects with similar design loads and controlled settlement to the project tolerances.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of documented experience with a record of successful in-service performance on projects with similar design loads and controlled settlement to the project tolerances. The design and installation shall be conducted and overseen by a registered professional engineer employed by the Contractor. material, design and scope to this Project..
  1. Installer shall maintain Quality Control records during pier installation.
  2. Installer shall provide a certified quality control representative to observe the drilling and construction of all engineered aggregate piers. Quality Control observations shall include confirmation that all aggregate lifts have been constructed to the design criteria, as established by the aggregate pier design engineer.
- C. Modulus Testing Standards: ASTM D 1143 - Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
- D. Uplift Testing Standards: ASTM D 3689 - Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
- E. Materials and Inspections Standards: ASTM D 1241 - Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses
- F. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

## PRODUCTS

### 2.01 MATERIALS

- A. Aggregate: In accordance with ASTM C33/C33M with gradation requirements as specified by the aggregate pier engineer. During wet weather conditions, the aggregate shall contain less than 5 percent fines.
- B. Uplift anchors shall be constructed of hot-dip galvanized structural steel and designed by aggregate pier engineer, with minimums as indicated on Drawings.

## EXECUTION

### 3.01 PREPARATION

- A. Examine areas and conditions under which aggregate piers are to be installed.
- B. Use placement method that will not cause damage to nearby structures.
  - 1. If an adjacent building is within 15 ft of the aggregate pier work area, a relevant building examination shall be performed prior to initiating work to document preexisting cracks/damage. The building must also be monitored for movement during any work within 15 ft of the structure. The work shall be stopped, and the engineer notified if any building settlement is observed.
- C. Site subgrade established shall be within 6 inches of finish subgrade, or as approved by the aggregate pier contractor.
- D. Existing Utilities:
  - 1. Locate existing underground utilities before excavating for piers. If utilities are to remain in place, provide protection from damage during operations.
  - 2. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
- E. Interruption of Existing Utilities:
  - 1. Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
    - a. Notify Owner no fewer than two days in advance of proposed interruption of utility.
    - b. Do not proceed with interruption of utility without Owner's written permission.
- F. Prepare to place piers from excavated working elevation. Do not begin installation until ground elevation at each pier location is at least 12 inches (305 mm) higher than indicated top bearing level of pier, or as approved by the aggregate pier designer.
- G. Geotechnical Report: Reference the geotechnical report prepared for this Project. The opinions expressed in the report at those of the geotechnical engineer and represent interpretations of the subsoil conditions, test, and result of analyses conducted by the geotechnical engineer. The Owner is not responsible for the interpretations or conclusions from this data.
  - 1. The boring log and accompanying report are believed to be accurate; however, neither the owner, architect, nor structural engineer guarantees the information contained therein, nor do they guarantee the conditions indicated to exist at the locations of the test holes will prevail at other locations on the site.
- H. Survey Work: Engage a qualified surveyor to perform surveys, layouts, and measurements for aggregate piers. Before excavating, lay out each aggregate pier to lines and levels required. Record actual measurements of each pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

- I. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Drill concentric and vertical pier shafts to diameters and depths indicated.
- B. Remove loose material from shaft sides and bottom. Maintain shafts free of water.
- C. Set top bearing levels of piers to elevations indicated.
- D. The aggregate pier contractor shall use one of the following construction methods:
  1. Down-Hole Vibrator.
  2. Down-Hole Tamper/Rammer
- E. Prior to installing production piers, the aggregate pier engineer shall establish the required energy output to achieve compaction of each lift. Energy output shall be confirmed by the contractor prior to construction of production piers.
  1. Where down-hole vibrator construction method is used, an appropriate metering device should be provided at such a location that inspection of amperage increase may be verified during the operation of the equipment. The metering device may be an ammeter directly indicating the performance of the vibrator tip.
  2. Where down-hole tamper/rammer construction method is used, rammer-blow deflection monitoring shall be performed randomly on a minimum of 10% of the installed piers to confirm that terminal rammer-blow deflections meet the established acceptance criterion. The aggregate pier engineer shall establish the required energy output for the rammer and establish terminal rammer-blow deflection criterion. Instrumentation used to confirm rammer-blow deflections shall be capable of recording to a precision of at least 0.001 inch per rammer stroke and shall be capable of recording deflection accompanying each rammer blow. During pier construction, rammer-blow deflections shall be monitored to confirm that the design deflection per rammer-blow is achieved.
- F. Stable Ground Conditions: The following general procedures shall be followed when the pre-drilled hole remains open during construction.
  1. Pre-drilling to the design depth will be performed with an auger diameter equal to the finished column diameter.
  2. Down-Hole Vibrator Method: The quantity of aggregate initially added shall be such that the vibrator tip is able to penetrate to within 12 inches of the design depth. The vibrator will be raised and lowered repeatedly, such that on each re-penetration, the tip of the vibrator advances to within 12 inches of the previous penetration depth.
  3. Down-Hole Tamper/Rammer Method: The bottom of the pier excavation shall be compacted prior to the placement of aggregate. If wet, soft or sensitive soils are present, open graded aggregate shall be placed and to stabilize the pier bottom and may serve as the initial pier lift. Following placement of the first lift of aggregate, the tamper/rammer is to be lowered to the top of the aggregate and activated. Subsequent lifts shall not exceed thickness determined by the aggregate pier engineer.
  4. The aggregate shall be removed and replaced with fresh aggregate if cave-ins occur during the aggregate placement such that the volume of caved-in soil is greater than 10 percent of the aggregate being compacted.
- G. Unstable Ground Conditions: The following general procedures will be followed when a pre-drilled hole will not remain open before or during pier construction.
  1. Down-Hole Vibrator Method: If the hole will remain temporarily stable, the hole may be filled with aggregate to a level above the instability as long as the vibrator is still able to penetrate to within 1 foot of the pre-drilled depth. If the hole will not remain temporarily stable, a Bottom Feed Down-Hole vibrator may be used.
  2. Down-Hole Tamper/Rammer Method: A casing with a minimum outside diameter equal to 100% of the pier diameter is advanced to the full treatment depth. The bottom of the pier excavation shall be compacted prior to the placement of aggregate. Open graded aggregate shall be placed to stabilize the pier bottom and may serve as the initial pier lift.

Subsequent lifts shall not exceed thickness determined by the aggregate pier engineer. The casing is extracted after each lift is compacted with the bottom of the casing always maintained below the top of the aggregate.

- H. Should any obstruction, including but not limited to cobbles, boulders, timber, concrete, asphalt, large roots etc., be encountered which prevents placing the elements to the required depth, or causes the aggregate pier to drift from the required location, the obstruction shall be removed. Additional aggregate pier elements shall be installed when required by the presence of obstacles.
- I. The center of each constructed aggregate pier element shall be within 6 inches of the design location. Foundation elements installed outside of the above tolerance and deemed not to be acceptable, shall be either rebuilt or other remedial measures taken as approved by the aggregate pier system engineer.
- J. Casing for elevator jack shafts located within 10 feet horizontally of any aggregate element shall be installed prior to aggregate pier installation and shall be grouted in-place for the full length of the casing.
- K. Acceptable constructed lift thickness shall be established by the aggregate pier engineer and confirmed by the aggregate pier contractor for each lift installed.
- L. Required compaction for each lift shall be established by the aggregate pier engineer and shall be consistent with the criteria used for the test pier construction.
- M. Aggregate piers installed beyond the maximum allowable tolerances shall be abandoned and replaced with new piers, unless the aggregate pier engineer approves the condition or provides other remedial measures. All material and labor required to replace rejected piers shall be provided at no additional cost to the Owner, unless the cause of rejection is due to an obstruction.

### 3.03 AGGREGATE MODULUS TESTING:

- A. In accordance with ASTM D1143.
  - 1. Testing to determine specification compliance shall be provided by the aggregate pier contractor and will consist of at least one modulus test of an aggregate pier.
- B. Where down-hole tamper/rammer construction method is used, modulus test data shall be used by the aggregate pier system engineer to supplement rammer blow deflection monitoring to confirm aggregate pier element design parameters for the project. Test piers used for modulus testing shall be constructed using rammer deflection monitoring.
- C. Aggregate pier elements used for modulus testing which are located within tolerance and provide a safe design capacity may, upon approval of the aggregate pier system engineer, be used in the finished work.
- D. Compressive load test: Test pier shall be loaded to 150 percent of the estimated element design pressure or test may be terminated when modulus equals 150 percent of the modulus used in design .
- E. Modulus test shall be conducted as follows:
  - 1. ASTM D1143 test procedures shall be used as a guide to establishing load increments, load increment duration, load decrements, and total applied load.
  - 2. The test pier shall be constructed in such a manner that deflections at both the bottom and top of the pier can be measured at each increment of loading.
  - 3. With the exception of load increments representing up to approximately 112% of design maximum aggregate pier element stress must hold for a minimum of 15 minutes and a maximum of 1 hour, and until deflection reduces to 0.01 inch per hour or less.
  - 4. Load increments representing approximately 112% of design maximum aggregate pier element stress must hold for a minimum of 15 minutes and a maximum of 4 hours, and until deflection reduces to 0.01 inch per hour or less.



5. A seating load equal to 5 percent of total shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.
6. The test data shall be presented as a graph showing deflection of the pier top and bottom under each load increment.
7. At the design load, deflection measured at the top of the pier shall not exceed the design settlement for the aggregate pier-reinforced soil zone, and the ratio of bottom plate deflection to top plate deflection shall not exceed 0.25 unless specifically approved by the aggregate pier engineer.

### 3.04 AGGREGATE PIER UPLIFT TESTING

- A. If uplift loaded aggregate piers are specified for this project, testing to determine specification compliance shall be provided by the aggregate pier contractor, and will consist of at least one uplift test of an aggregate pier.
- B. In addition to specifications within this section, ASTM D3689 shall be the general guide in establishing uplift load test procedures. The uplift load test will be performed as described in the Design Submittal.
- C. Verification that the design of the aggregate pier system is in accordance with the performance observed during the uplift load test shall be attained through information acquired during the uplift load test.

### 3.05 FOOTING SUBGRADE PREPARATION

- A. Prepare pier top to receive spread footing and strip footing, free of water and to meet Geotechnical Engineer's recommendation for subgrade and is the responsibility of the Contractor.
- B. Foundation excavations to expose the tops of aggregate pier elements shall be made in a workmanlike manner, and shall be protected until concrete placement, with procedures and equipment best suited to (1) prevent softening of the matrix soil between and around the aggregate pier elements before pouring structural concrete, and (2) achieving direct and firm contact between the dense, undisturbed aggregate pier elements and the concrete footing.
- C. Footing excavations shall be kept free of water.
- D. Foundation excavations shall be constructed as follows:
  1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment). Over-excavation shall be backfilled with material matching aggregate pier.
  2. Compaction of surface soil and top of aggregate pier elements shall be prepared using a motorized impact compactor ("Wacker Packer," "Jumping Jack," or similar). Sled-type tamping devices shall not be used. Compaction shall be performed over the entire footing bottom to compact any loose surface soil and loose surface pier aggregate.
  3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on expansive or sensitive soils.
  4. If same day placement of footing concrete is not possible, place a minimum 3-inch thick lean concrete seal ('mud mat') immediately after the footing is excavated and approved or an alternative subsurface protection layer that may consist of a geotextile fabric and six inches of crushed stone to prevent softening or disturbance of the subgrade soils.
  5. Confirm that immediately before footing construction or placement of an alternate subgrade protection layer, the tops of all the aggregate pier elements exposed in each footing excavation have been inspected and recompact as necessary with mechanical compaction equipment, and that the tops of any aggregate pier elements which may have been disturbed by footing excavation and related activity have been recompact to a dry

density equivalent to at least 95% of the maximum dry density obtainable by the modified Proctor method (ASTM D-1557).

- E. No excavations or drilled shafts (elevator, etc) shall be made after installation of Aggregate Pier elements within a horizontal distance of 10' from the edge of any pier, without the written approval of the aggregate pier contractor.

### 3.06 TOLERANCES

- A. Maximum Variation From Vertical: 1 in 48, or as deemed acceptable by Designer.
- B. Maximum Variation From Design Top Elevation: as deemed acceptable by Designer.
- C. Maximum Out-of-Position: as deemed acceptable by Designer.

### 3.07 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 014000 - Quality Requirements & 014533 - Code-required Special Inspections and Procedures
- B. The aggregate pier contractor shall have a full-time, on-site Quality Control representative to verify and report all installation procedures. The contractor shall immediately report any unusual conditions encountered during installation to the aggregate pier engineer, the General Contractor, and to the Special Inspection Agency. Submit daily aggregate pier progress reports, as indicated.
- C. Aggregate Pier Inspections: The special inspector shall log the following during installation for comparison with anticipated conditions and design parameters (from the engineer/contractor):
  - 1. Pier Identification
  - 2. Plan Top Elevation
  - 3. Date of Excavation
  - 4. Actual Ground Elevation
  - 5. Designed Pier Length
  - 6. Designed Pier Diameter
  - 7. As-Installed Depth of Pier Excavation
  - 8. As-installed Pier Bottom Elevation
  - 9. As-installed Total Pier Length
  - 10. Soil Type(s) Encountered by Pier Excavation
  - 11. Soil Type at Pier Excavation Bottom
  - 12. Date of Aggregate Placement
  - 13. Type/Description of Aggregate
  - 14. Number of Aggregate Lifts Placed
  - 15. Average Aggregate Lift Thickness
  - 16. Actual Compaction Time
  - 17. Rammer Blow Deflections (for down-hole tamper/rammer construction method)
  - 18. Energy Output
  - 19. Length of Casing Installed (if any)
- D. Footings bearing on Aggregate Piers: The special inspector shall confirm:
  - 1. That water (which may soften the unconfined matrix soil between and around the aggregate pier elements and may have detrimental effects on the supporting capability of the aggregate pier reinforced subgrade) is not ponding in the footing and there is no evidence of previous water ponding.
  - 2. That all aggregate pier elements designed for each footing have been exposed in the footing excavation.
  - 3. That immediately before footing construction, the tops of aggregate pier elements exposed in each footing excavation have been inspected and recompact as necessary with mechanical (*not vibratory*) compaction equipment; and that the tops of any pier

elements which may have been disturbed by footing excavation and related activity have been recompact to a dry density equivalent to at least 95% of the maximum dry density obtainable by the modified AASHTO compaction procedure (ASTM D1557).

4. That any structural fill placed between the tops of aggregate pier elements and the bottoms of foundations consists of the same quality and gradation material, or better, as used in constructing the piers; and that the fill has been compacted to a dry density equivalent to at least 95% of the maximum dry density obtainable by the modified AASHTO compaction procedure (ASTM D1557);
5. That no excavations or drilled shafts (elevator, etc) have been observed within a horizontal distance of 10' from the edge of any pier.

### 3.08 UNACCEPTABLE PIERS

- A. Unacceptable Piers: Piers that fail, are placed out of position, are below elevations, or are damaged.
- B. Abandon unacceptable piers in place. Provide additional piers as directed by independent inspector.

END OF SECTION 316613.13

## SECTION 320516 - AGGREGATES FOR EXTERIOR IMPROVEMENTS

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. Summary: The work of this section shall include excavation, grading and installation of boulders placed at the locations shown on the Drawings. The materials to be used for the construction of such structures shall be as specified herein:

- 1. Sandstone Seat / Landscape Boulders.

#### 1.02 RELATED SECTIONS

- A. Division 32 - Section "Irrigation" for sprinkler irrigation requirements in and around Rock Work specified here-in.
- B. Division 32 - Section "Plants".
- C. Division 32 - Section "Turf and Grasses".

#### 1.03 SUBMITTALS AND SHOP DRAWINGS

- A. The Contractor shall submit photos of each specified boulder(s) that represents the full range of colors / staining that can be expected, for review/selection by the Owner's Representative.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Seat / Landscape Boulders
  - 1. Stone Type: Buff Sandstone
  - 3. Sizes shall be as indicated on the Drawings. Where plans do not specify specific sizes, boulder sizes shall range between 0.75 ton and 1.5 tons (18"h. x 18" - 24"w. x 4' - 6' long). An even mix of sizes shall be provided (not all 0.75 ton).

### PART 3 - EXECUTION

#### 3.01 SELECTION OF STONE

- A. Contractor shall submit photos of available stones/boulders for the District's Owner's Representative review/selection. Include a ruler/tape measure in photos to illustrate scale.

3.02 HANDLING

- A. Handling of the stone/boulders shall be carried out in such a way that the boulders are not damaged or scarred. Damage boulders may be rejected by the District's Owner's Representative.

3.03 PLACEMENT

- A. Placement of Seat / Landscape Boulders:
  - 1. Place boulders with flattest side up and most attractive face (as determined by Owner's Representative) facing activity areas, unless otherwise noted or directed by the Owner's Representative.
  - 2. Exposed edges must be rounded/not sharp/not jagged. Contractor may need to chisel / cut boulders to fit tight. Cut edges shall not be visible.
  - 3. Tolerance: Top of boulder elevations shall be within 0.1' of the elevation indicated on the drawings / detailed.
  - 4. Bury approximately one-third (1/3) the height of the boulder, unless otherwise noted.
  - 5. Locations and quantity shall be as indicated in the Drawings. Final placement of boulders may be reviewed and approved on site by the Owner's Representative prior to placing paving, surfacing and / or landscaping in abutting areas.
  - 6. Provide sealed expansion joint around the perimeter of the boulder that abuts concrete paving or curbs as indicated in the detailing.

3.05 CLEAN UP

- A. Remove unneeded stone debris from the site.
- B. Clean dirt, debris, trash and other deleterious material from stone surfaces and surrounding areas.

END OF SECTION 320516

## SECTION 321123 - AGGREGATE BASE COURSES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Aggregate base course.

#### 1.02 RELATED REQUIREMENTS

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report; bore hole locations, findings of subsurface materials, and recommendations.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 033100 - Site Concrete Work
- D. Section 312201 - Grading
- E. Section 312316.13 - Trenching
- F. Section 312323 - Fill
- G. Section 321216 - Asphalt Paving
- H. Section 321313 - Concrete Paving
- I. Section 321613 - Curb and Gutter
- J. Section 321623 - Sidewalks
- K. Section 330500 - Manholes
- L. Section 334100 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.

#### 1.03 REFERENCE STANDARDS

- A. AASHTO M 6 - Fine Aggregate for Portland Cement Concrete.
- B. AASHTO M 80 - Coarse Aggregate for Portland Cement Concrete.
- C. AASHTO T 2 - Sampling of Aggregates.
- D. AASHTO T 27 - Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
- E. AASHTO T 27 (Wyoming Modified) - Sieve Analysis of Fine and Coarse Aggregates.
- F. AASHTO T 96 - Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
- G. AASHTO T 104 - Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate.
- H. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- I. AASHTO T 191 (Wyoming Modified) - Density of Soil in Place (Sand Cone Method).

- J. ASTM C117 - (2023 ed).
- K. ASTM C131/C131M - Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- L. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- M. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
- N. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- O. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
- P. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- Q. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- R. ASTM D3665 - Standard Practice for Random Sampling of Construction Materials.
- S. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- T. ASTM D5821-13 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
- U. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. The Contractor will test materials and submit one (1) copy of the results to the Architect/Engineer within 24 hours for the following:
  - 1. One (1) optimum moisture/density curve for each source of material, performed in accordance with ASTM D698.
  - 2. One (1) sieve analysis and Atterberg Limits and aggregate properties analysis per source tested in accordance with ASTM C136/C136M, ASTM C117, and ASTM D4318.
- D. The Contractor shall submit Certificates of Compliance for all aggregates showing that the materials will comply with these specifications before the materials will be approved for use.
- E. Compaction Density Test Reports.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When aggregate materials need to be stored on site, locate in areas approved by the Architect/Engineer.

C. Aggregate Storage, General:

1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
2. Prevent contamination.
3. Protect stockpiles from erosion and deterioration of materials.
4. Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates and the site shall be firm and smooth and well drained. A bed of aggregate suitable to avoid the inclusion of soil or foreign material shall be maintained.
5. Stockpiles shall be built in layers not exceeding four (4) feet in height, and each layer shall be completely in place before the next layer is started so as to prevent segregation. The material shall be deposited in such a manner as to prevent coning, except in the case of fine aggregate composed of material approximately ninety percent (90%) finer than a #4 sieve.
6. Dumping, casting, or pushing over sides of stockpiles is prohibited except in the case of fine aggregate materials.
7. When it is necessary to operate trucks or other equipment on the stockpile in the process of building that stockpile it should be done in a manner approved by the Architect/Engineer. Any method of stockpiling aggregate, which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate, will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated. Failure of such samples to meet all grading requirements for the aggregate s
8. The aggregate shall be transferred from the stockpiles in such a way as to obtain a material having a uniform grading.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Aggregates shall be crushed and free of organic or vegetative matter, clay balls, frozen lumps, or other extraneous matter and shall conform to the specifications and grading for the various classes required.
- B. Crushed base courses shall be crushed stone, crushed gravel, crushed concrete, or recycled asphalt pavement, and an approved soil binder or natural filler, where required, conforming to the following requirements, unless otherwise designated in the Contract Documents.
  1. Coarse aggregate shall consist of hard, durable particles or fragments of stone, gravel, crushed concrete, or other approved inert materials of similar characteristics or combinations thereof. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used.
    - a. At least 50% of the material by mass retained on the No. 4 (4.75 mm) sieve shall have at least one fractured face.
    - b. Unless otherwise specified, the coarse aggregate shall have a percentage of wear of not more than forty (40) when tested in accordance with AASHTO T 96. The sodium sulfate soundness loss shall not exceed twelve percent (12%) in accordance with AASHTO T 104. The angularity shall have a minimum value of seventy-five percent (75%) in accordance with ASTM D5821-13.
  2. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand.
    - a. The fraction passing the #200 sieve shall not be greater than two-thirds (2/3) of the fraction passing the #40 sieve.
    - b. The fraction passing the #40 sieve shall have a liquid limit not greater than twenty-five (25) and a plasticity index not greater than three (3) except that, when the plasticity index is non-plastic (NP), the liquid limit shall not be more than thirty (30).



3. Crushed base courses shall meet the classification of "Grading W", meeting the following gradation requirements tested in accordance with ASTM C117 and ASTM C136/C136M:
    - a. 1-1/2 inch sieve: 100 percent passing.
    - b. 1 inch sieve: 90 to 100 percent passing.
    - c. 1/2 inch sieve: 60 to 85 percent passing.
    - d. No. 4 sieve: 45 to 65 percent passing.
    - e. No. 8 sieve: 33 to 53 percent passing.
    - f. No. 200 sieve: 3 to 12 percent passing.
  4. Where "Grading W" is unavailable "Grading L", meeting the following gradation requirements tested in accordance with ASTM C117 and ASTM C136/C136M may be used with the approval of the Architect/Engineer:
    - a. 1-1/2 inch sieve: 100 percent passing.
    - b. 1 inch sieve: 90 to 100 percent passing.
    - c. 1/2 inch sieve: 60 to 85 percent passing.
    - d. No. 4 sieve: 35 to 55 percent passing.
    - e. No. 8 sieve: 25 to 50 percent passing.
    - f. No. 30 sieve: 10 to 30 percent passing.
    - g. No. 200 sieve: 3 to 15 12 percent passing.
- C. Aggregate for Drains shall be crushed or natural sand and gravel or other approved free-draining material. The material shall be uniformly graded from coarse to fine within the following gradation requirements for the material type indicated in the Contract Documents. When the grading is not indicated in the Contract Documents, Grading B Shall be used. Plasticity index shall not be greater than 3.

1.

| Sieve Designation | % by Weight Passing |           |           |
|-------------------|---------------------|-----------|-----------|
| Inches            | Grading A           | Grading B | Grading C |
| 2"                | 100                 | --        | --        |
| 1 1/2"            | 95-100              | 100       | --        |
| 1"                | --                  | 95-100    | --        |
| 3/4"              | 35-70               | --        | 100       |
| 3/8"              | 10-30               | --        | 95-100    |
| #4                | 0-5                 | 0-10      | --        |
| #8                | --                  | --        | 65-95     |
| #16               | --                  | --        | 5-30      |
| #100              | --                  | --        | 0-10      |

## 2.02 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of aggregate materials.
- B. Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance before delivery to site.
- C. Sampling and testing of aggregates for flexible pavements shall be in accordance with the following standard methods of the AASHTO:
  1. Sampling: AASHTO T 2
  2. Percentage of Wear: AASHTO T 96
  3. Soundness: AASHTO T 104
  4. Sieve Analysis: AASHTO T 27 (Wyoming Modified)

- D. Sampling and testing of aggregates for Portland cement concrete shall be in accordance with the following standard methods of the AASHTO:
  - 1. Fine Aggregate: AASHTO M 6
  - 2. Coarse Aggregate: AASHTO M 80
  - 3. Sieve Analysis: AASHTO T 27 (Wyoming Modified)
  - 4. Percentage of Wear: AASHTO T 96
  - 5. Soundness: AASHTO T 104
- E. Sampling and testing of aggregates shall be performed by an independent laboratory. Each pit or stock-piled source for aggregate material shall be tested and qualified to meet the applicable specifications at minimum on an annual basis. The Architect/Engineer may require random sampling and testing of source material at their discretion.
- F. 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.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

#### 3.02 PREPARATION

- A. See Section 312201 - Grading of the project specifications for subgrade preparation.
- B. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- C. No surface material shall be placed upon a frozen, muddy, yielding, or rutted sub-grade or gravel surface.

#### 3.03 INSTALLATION

- A. Perform work in accordance with the referenced geotechnical engineering report.
- B. If the required compacted depth of any aggregate surfacing course exceeds 6 inches, it shall be constructed in two or more layers of approximate equal thickness; the maximum compacted thickness of any one layer shall not exceed 6 inches. The material shall be deposited and spread in a uniform layer, with no segregation of size. When vibrating or other approved types of special compacting equipment are used, the depth of a single layer of the course may be increased upon approval by Architect/Engineer.
- C. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture and surface is produced and the aggregates firmly keyed. Water shall be uniformly applied over the materials during compaction in the amount necessary for proper consolidation.
- D. In no case shall the addition of thin layers of material be added to the top layer of crushed base to meet grade.
- E. Grades for the top layer which are 1/2 inch, or more, from the design elevation shall be scarified to a depth of at least 3 inches, new material added or removed, and the layer shall be blended and re-compacted to bring it to grade.

- F. Unless noted otherwise below, compaction shall achieve a minimum density of 93 % of maximum density in accordance with AASHTO T 180 ("modified Proctor") or ASTM D1557 ("modified Proctor") . The moisture content will be within minus 2 % to plus 2 % of optimum moisture, and the surface shall be stable with no soft spots, prior to placing asphalt or concrete.
- G. Under Asphalt Pavement:
1. A minimum depth of 12 inches of crushed aggregate base course material shall be placed and compacted to 93 % of maximum dry density in accordance with AASHTO T 180 ("modified Proctor") or ASTM D1557 ("modified Proctor") within minus 2 % to plus 2 % of optimum moisture content. A firm, even surface shall be established under all asphalt pavement.
  2. All soft, yielding, and otherwise unsuitable material shall be removed and replaced with suitable material.
- H. Under Recycled Asphalt Pavement:
1. A minimum depth of 7 inches of crushed aggregate base course material shall be placed and compacted to 93 % of maximum dry density in accordance with AASHTO T 180 ("modified Proctor") or ASTM D1557 ("modified Proctor") within minus 2 % to plus 2 % of optimum moisture content. A firm, even surface shall be established under all recycled asphalt pavement.
  2. All soft, yielding, and otherwise unsuitable material shall be removed and replaced with suitable material.
- I. Gravel with Recycled Asphalt Capped Pavement
1. A minimum depth of 12 inches of crushed aggregate base course material shall be placed and compacted to 93 % of maximum dry density in accordance with AASHTO T 180 ("modified Proctor") or ASTM D1557 ("modified Proctor") within minus 2 % to plus 2 % of optimum moisture content. A firm, even surface shall be established under all recycled asphalt pavement.
  2. All soft, yielding, and otherwise unsuitable material shall be removed and replaced with suitable material.
- J. Under Portland Cement Concrete Pavement:
1. A minimum depth of 6 inches of crushed aggregate base course material shall be placed and compacted to 93 % of maximum dry density in accordance with AASHTO T 180 ("modified Proctor") or ASTM D1557 ("modified Proctor") within minus 2 % to plus 2 % of optimum moisture content. A firm, even surface shall be established under all concrete pavement.
  2. All soft, yielding, and otherwise unsuitable material shall be removed and replaced with suitable material.
- K. Under Curb and Gutter:
1. Excavation shall be as required to permit placing of curb, gutter, and/or combined curb and gutter to the lines as shown in the Plans.
  2. A minimum depth of 6 inches of crushed aggregate base course material shall be placed and compacted to 93 % of maximum dry density in accordance with ASTM D698 within minus 2 % to plus 2 % of optimum moisture content. A firm, even surface shall be established under all curb and gutter. This requirement is waived if curb and gutter is installed on a portion of street where the base course material is 8 inches or more in thickness.
  3. All soft, yielding and otherwise unsuitable material shall be removed and replaced with suitable material. Filled sections shall be compacted and extended a minimum of 1 foot outside the form lines.

L. Under Sidewalk:

1. Excavation shall be as required to permit placing of sidewalk to the lines as shown in the Plans.
2. A minimum depth of 6 inches of crushed aggregate base course material shall be placed and compacted to 93 % of maximum dry density in accordance with ASTM D698 within minus 2 % to plus 2 % of optimum moisture content. A firm, even surface shall be established under all sidewalks.
3. All soft, yielding and otherwise unsuitable material shall be removed and replaced with suitable material. Filled sections shall be compacted and extended a minimum of 1 foot outside the form lines.

3.04 RESTRICTIONS

- A. In addition to the restrictions imposed by Federal, State, County, and City law on hauling vehicles, including weight restrictions, the Contractor shall restrict the speed of the hauling units and the weight of loads as he deems necessary to prevent damage to the subgrade, base, surface courses, or public thoroughfares used.

3.05 TOLERANCES

- A. Surface smoothness/flatness shall not vary by more than 0.04 feet when measured with a 10-foot straight edge.
- B. The surface elevation shall be within 0.04 feet of its design position in all locations and shall allow the asphalt and concrete to be placed to the elevations, grade, thickness, and crown required by the plans and specifications.
- C. The completed thickness of the base course shall be within 0.05 feet of the design thickness.

3.06 PROTECTION

- A. Hauling equipment may be routed over completed portions of the base course, provided no damage results and provided that such equipment is routed over the full width of the base course to avoid rutting or uneven compaction. Any rutting, soft spots, or damage to subgrade or aggregate courses shall be repaired by the Contractor at his expense, to the satisfaction of the Architect/Engineer.

3.07 MAINTENANCE

- A. In area where asphalt pavement is to be placed over the base course the Contractor shall perform all maintenance work necessary to keep the base course in a condition satisfactory for priming and/or paving. The surface shall be kept clean and free from foreign material. The base course shall be properly drained at all times. If cleaning is necessary, or if the graded surface becomes disturbed, any work or restoration necessary shall be performed at the expense of the Contractor.
- B. Before preparations begin for the application of a surface treatment or for a surface course, the base course shall be allowed to partially dry until the average moisture content of the full depth of base is less than 80 percent of the optimum moisture of the base mixture. The drying shall not continue to the extent that the surface of the base becomes dusty with consequent loss of binder. If during the curing period the surface of the base dries too fast, it shall be kept moist by sprinkling. The base course must be stable as final surfacing is placed.

3.08 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Owner will engage soil testing/inspection service from a qualified testing laboratory acceptable to the Architect/Engineer for quality testing during construction per Section 014000 - Quality Requirements.
- C. Testing laboratory shall provide Architect/Engineer with copies of all test reports within 24 hours of tests.
- D. Contractor shall allow testing service to inspect and Architect/Engineer to approve subgrade and fill layers before further construction work is performed.
- E. In-place quality control density testing shall be completed in accordance with AASHTO T 191 (Wyoming Modified) or ASTM D2922. The gage shall be calibrated in accordance with the annex of ASTM D6938.
- F. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180 ("modified Proctor") or ASTM D1557 ("modified Proctor").
- G. If tests indicate materials do not meet specified requirements, the Contractor shall provide additional watering, blending of material, and/or remove and replace work before retesting.
- H. Should conditions become present following a passing compaction test that cause a change in the conditions of the compacted crushed aggregate base course (such as precipitation from a storm event) prior to the placement of a subsequent lift or section, then the area(s) shall be retested, at the discretion of the Architect/Engineer, to confirm adequate compaction.
- I. Crushed base shall be accepted for density on a lot basis consisting of 500 square yards. Sampling locations will be determined by the testing laboratory, or as directed by the Architect/Engineer, on a random basis in accordance with ASTM D3665.
- J. Compaction tests taken for crushed base under curb and gutter shall be taken at a minimum of one density test per 200 linear feet.
- K. Compaction tests taken for crushed base under sidewalk shall be taken at a minimum of one density test per 1,200 square feet.
- L. Compacted satisfactory base course shall further be determined by proof-rolling with equipment approved by the Architect/Engineer prior to use. Proof-rolling equipment shall be a loaded tandem axle dump truck, or similar piece of equipment, having pneumatic tires and weighing not less than 27 tons. Each succeeding pass of the proof-roller over the roadbed shall be offset by not greater than one tire width. Limit vehicle speed to 3 mph. Excavate soft spots and areas of excessive pumping or rutting, as determined by Architect/Engineer, and replace with compacted material as directed.

### 3.09 CLEANING

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

END OF SECTION 321123

## SECTION 321216 - ASPHALT PAVING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Single course bituminous concrete paving.
- C. Double course bituminous concrete paving.

#### 1.02 RELATED REQUIREMENTS

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report, bore hole locations, findings of subsurface materials, and recommendations.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 033100 - Site Concrete Work
- D. Section 312201 - Grading
- E. Section 312323 - Fill
- F. Section 321123 - Aggregate Base Courses
- G. Section 321313 - Concrete Paving
- H. Section 321713 - Parking Bumpers
- I. Section 321723.13 - Painted Pavement Markings
- J. Section 330500 - Manholes

#### 1.03 REFERENCE STANDARDS

- A. AASHTO M 81 - Standard Specification for Cutback Asphalt (Rapid-Curing Type).
- B. AASHTO M 82 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
- C. AASHTO M 140 - Standard Specification for Emulsified Asphalt.
- D. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
- E. AASHTO M 208 - Standard Specification for Cationic Emulsified Asphalt.
- F. AASHTO R 66 - Standard Practice for Sampling Asphaltic Materials.
- G. AASHTO T 78 - Standard Method of Test for Distillation of Cutback Asphalt Products.
- H. AASHTO T 283 - Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage.
- I. AI MS-2 - Asphalt Mix Design Methods.

- J. AI MS-19 - Basic Asphalt Emulsion Manual.
  - K. ASTM C117 - (2023 ed).
  - L. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - M. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
  - N. ASTM D979 - Standard Practice for Sampling Asphalt Mixtures.
  - O. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Coated Samples.
  - P. ASTM D2041/D2041M - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures.
  - Q. ASTM D2172 - Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures.
  - R. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - S. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt Mixtures.
  - T. ASTM D2950/D2950M - Standard Test Method for Density of Asphalt Mixtures in Place by Nuclear Methods.
  - U. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Asphalt Mixture Specimens.
  - V. ASTM D3665 - Standard Practice for Random Sampling of Construction Materials.
  - W. ASTM D4125 - Standard Test Methods for Asphalt Content of Asphalt Mixtures by the Nuclear Method.
  - X. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  - Y. ASTM D5361 - Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing.
  - Z. ASTM D5444 - Standard Test Method for Mechanical Size Analysis of Extracted Aggregate.
  - AA. ASTM D6307 - Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method.
  - BB. ASTM D6926 - Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus.
  - CC. ASTM D6927 - Standard Test Method for Marshall Stability and Flow of Asphalt Mixtures.
  - DD. FHWA MUTCD - Manual on Uniform Traffic Control Devices.
- 1.04 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Job Mix Formula: Submit at least thirty (30) days prior to the date the Contractor expects to begin paving operations for approval by the Architect/Engineer. A job mix formula shall be submitted for each mixture to be supplied for the project.
- C. Certificates: Submit certificates of compliance with Specifications for all asphalt material and aggregates signed by material producer and Contractor. Certificate of Compliance shall be provided to Architect/Engineer with each load of Asphaltic Materials. The Architect/Engineer may obtain a sample of each load of Asphaltic Material and that sampling shall be accomplished using methods described and outlined in AASHTO R 66.

#### 1.05 QUALITY ASSURANCE

- A. Perform work in accordance with the City of Gillette standards.
- B. Mixing Plant: Conform to the Wyoming Department of Transportation standards.
- C. Obtain materials from same source throughout.

#### 1.06 PRODUCT HANDLING

- A. Delivery and Asphaltic Mixture: The mixture shall be delivered to the area to be paved in such a manner that the temperature at the time of discharging into the paver will not be less than that hereinafter specified.
  - 1. Each truck shall be capable of being equipped with a canvas cover or other suitable material of such size as to prevent unnecessary heat loss and to protect the mixture from the weather. Any loads wet excessively by rain will be rejected. Trucks shall have tight, clean, smooth metal beds, coated with an approved material to prevent adhesion of the mix to the truck bed.
  - 2. Deliveries shall be made so that spreading and rolling of all the mixture prepared for a day's run can be completed during daylight, unless adequate and Architect/Engineer approved artificial light is provided.
  - 3. Delivery shall be made with the least possible impedance to normal flow of traffic and, when necessary, the Contractor will supply flagmen and/or traffic control devices consistent with State law and the Federal Highway Administration Manual on Uniform Traffic Control Devices (FHWA MUTCD), latest edition.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Aggregate
  - 1. The aggregate shall consist of crushed stone, crushed gravel, or sharp-edged natural sand with or without other inert finely divided particles, free from clay balls, organic matter, and other deleterious substances. Reclaimed Asphalt Pavement (RAP) will be permitted for use providing that all mixture properties are maintained. The aggregates shall not contain more than 8% by weight, of flat or elongated pieces. The crushed aggregate shall have a percentage of wear of not more than 40, and a sulfate soundness loss of not more than 12%, and shall be non-plastic.
    - a. All reference to coarse aggregate is that portion retained on the No. 4 sieve. The crushing of the aggregate shall result in a product in which the coarse aggregate (retained on the No. 4 sieve) shall have 100 percent by weight of particles with one or more fractured faces.
    - b. The fine aggregate, including any blended filler, shall have a maximum liquid limit of 25 and a maximum plasticity index of 6 when tested in accordance with ASTM D4318.



2. If filler, in addition to that naturally present in the aggregate, is necessary, it shall consist of stone dust, loess, Portland cement, or other approved mineral matter. Filler shall not exceed 15% of the total aggregate. The filler shall meet the requirements of AASHTO M 17.

**B. Bituminous Material**

1. The bituminous materials used for the project shall comply with the following table. The approximate amounts of materials per square yard and the application temperatures for the bituminous surface treatment shall be as shown in the following table:

| MATERIALS                                                                                                                                                                                                                                                                                      | SPECIFICATION                                                               | AMOUNT                                           | APPLICATION TEMPERATURES                         | USE                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Cutback Asphalt, MC-70                                                                                                                                                                                                                                                                         | AASHTO M 81, AASHTO M 82, AASHTO T 78                                       | 0.25 – 0.5 Gals./S.Y.                            | 80° - 150°F                                      | Prime Coat                                       |
| Emulsified Asphalt SS-1, CSS-1, SS-1h*, CSS-1h*                                                                                                                                                                                                                                                | (Anionic) AASHTO M 140 Modification<br>(Cationic) AASHTO M 208 Modification | 0.10 (+/- 0.02) Gals./S.Y.                       | 75° - 130°F                                      | Tack Coat                                        |
| PG 64– 28                                                                                                                                                                                                                                                                                      | ---                                                                         | To be determined by Contractor's job mix formula | To be determined by Contractor's job mix formula | To be determined by Contractor's job mix formula |
| *The designation "h" added to any grade of Emulsified Asphalt requires the residue from distillation to have a penetration from 40 to 90.                                                                                                                                                      |                                                                             |                                                  |                                                  |                                                  |
| The Letter "F" following the bituminous material type designation shall require a satisfactory antistripping agent be added to the material at the refinery. The presence of antistripping agents will be determined in accordance with the Wyoming Quick Bottle Test or other approved means. |                                                                             |                                                  |                                                  |                                                  |

**C. Composition of Mixture**

1. The bituminous plant mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula. The mix shall be designed by the Marshall Method in accordance with the most current edition of the Asphalt Institute MS-2 (AI MS-2) Manual and shall meet the following requirements:

| AASHTO T245                           |              |
|---------------------------------------|--------------|
| Number of blows each side of specimen | 50           |
| Stability (min)                       | 2,000 (min.) |

|                                                                                                                        |        |
|------------------------------------------------------------------------------------------------------------------------|--------|
| Flow (hundredths of an inch)                                                                                           | 8 -16  |
| Asphalt Content                                                                                                        | 4 - 7  |
| Percent Voids                                                                                                          | 4 to 5 |
| Percent void in mineral aggregate (VMA)                                                                                | *      |
| * For 3/4-inch nominal particle size: VMA of 12.0 to 15.0%<br>For 1/2-inch nominal particle size: VMA of 13.0 to 16.0% |        |

2. If the tensile strength ratio of the specimens of composite mixture, as determined by AASHTO T 283 is less than 75, the aggregates shall be rejected, or the asphalt shall be treated with an approved anti-stripping agent. The amount of anti-stripping agent added to the asphalt shall be sufficient to produce a tensile strength ratio of not less than 75. If an anti-stripping agent is required, it will be provided by the Contractor at no additional cost.
3. Job Mix Formula: Shall be within the master range specified. The allowable tolerances will be applied to the job mix formula. The job mix formula for each mixture shall be in effect until modified by the Architect/Engineer. The job mix formula for each mixture shall establish a single percentage aggregate passing each required sieve size and a single mixing temperature. The percentage of bituminous material to be added will also be designated by the job mix design.
  - a. The gradations in the table for Hot Plan Mix Bituminous Pavement represent the limits that shall determine suitability of aggregate for use from the sources of supply. The job mix gradation shall be within the limits designated in this table and shall be well graded from coarse to fine, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieves, or vice versa.
  - b. The bituminous content of the mixture shall be calculated on the percentage basis by weight of the total mix. The gradation of the aggregate for the Hot Plant Mix Bituminous Pavement shall conform with the 1/2-inch maximum as specified in the following table.

| HOT PLANT MIX BITUMINOUS PAVEMENT |                                                          |                                                          |
|-----------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| Sieve Sizes<br>(Square Openings)  | 1/2-inch Maximum<br>Total Percent Passing<br>(By Weight) | 3/4-inch Maximum<br>Total Percent Passing<br>(By Weight) |
| 1 1/4"                            | -                                                        | -                                                        |
| 1"                                | -                                                        | 100                                                      |
| 3/4"                              | 100                                                      | 90 - 100                                                 |
| 1/2"                              | 90 - 100                                                 | 55 - 90                                                  |
| 3/8"                              | 55 - 90                                                  | 45 - 85                                                  |
| No. 4                             | 35 - 70                                                  | 30 - 65                                                  |
| No. 8                             | 20 - 55                                                  | 20 - 50                                                  |
| No. 30                            | 5 - 35                                                   | 5 - 30                                                   |
| No. 200                           | 2 - 7                                                    | 2 - 7                                                    |

After the job mix formula is established all mixtures furnished for the project shall conform thereto with the following tolerances:

Passing No. 4 and larger sieves.....+/-7%

- |                                 |         |
|---------------------------------|---------|
| Passing No. 8.....              | +/-5%   |
| Passing No. 200.....            | +/-2%   |
| Asphalt Content.....            | +/-0.5% |
| Mixing Temperatures.....        | +/-20°F |
| Stability.....                  | >2000   |
| Flow hundredths of an inch..... | 8 - 16  |
| Air Voids.....                  | 2.5 - 5 |
| VMA (1/2").....                 | 12 - 16 |
4. Should changes in sources of materials be made, a new job mix formula shall be established before the new material is used.
  5. The combined mineral aggregate for the asphalt pavement shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the appropriate gradation in the table for Hot Plan Mix Bituminous Pavement, when tested in accordance with ASTM C117 and ASTM C136/C136M or ASTM D5444. The percentag of weight for the bituminous material shall be within the limits specified.

D. Recycled Asphalt Pavement (RAP)

1. Use Recycled Asphalt Pavement cold milled from existing on site asphalt pavement as called out in the construction documents to produce 2 inch maximum size material.

## 2.02 EQUIPMENT

- A. Distributor: Provide an asphalt distributor that is equipped, maintained, and operated to apply bituminous material uniformly at variable widths. Equip with a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, a thermometer for measuring temperatures of tank contents, a power unit for the pump, full circulation spray bars capable of being adjusted laterally and vertically, and a positive cut-off for the spray bars. The distributor shall be designed, equipped, and operated so that bituminous material at even heat can be applied uniformly on variable widths of surface at readily controlled rates from 0.05 to 2.0 gallons per square yard. The material shall be applied within a pressure range from 25 to 75 pounds per square inch and with an allowable variation from any specified rate not to exceed 5 percent.
- B. Asphalt Pavers: Asphalt pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated as necessary. It shall be capable of spreading and finishing courses of asphalt plant mix material which will meet the specified thickness, smoothness and grade. For typical street widths, the paver shall have a screed of sufficient width capable of spreading the plant mix material to a width equal to 0.5' wider than the distance from the centerline to edge of roadway or lip of gutter.
  1. The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.
- C. Rollers: Rollers shall be in good condition, capable of reversing without backlash, and operating at low speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while the mixture is still in a workable condition. Excessive crushing of the aggregate will not be permitted. Rollers shall be equipped with scrapers and water spray bars to keep plant mix material from sticking to rollers. Only water, or an Architect/Engineer approved agent, will be used on any drum to prevent adhesion. Petroleum based products shall not be permitted for use.

1. Wobble wheel rollers are not permitted. The rubber-tired rollers shall be self-propelled and consist of two axles, on which are mounted multiple pneumatic tired wheels not less than 7 wheels, in such a manner that the rear group of wheels will not flow in tracks of the forward group, and will be spaced to give uniform coverage with each pass. The axle shall be mounted in a rigid frame, provided with a loading platform or body suitable for ballasting. Total weight including ballast shall not exceed 30 tons. The tires shall be smooth and shall be capable of being inflated to pressures between 40 and 90 pounds per square inch. Tire pressures should not vary by more than 5 psi between individual tires. The roller shall be equipped with skirts to maintain the tire temperature.
2. Steel wheel rollers shall have a compactive effort of not less than a dynamic force of 21,000 pounds. The rate of travel shall not exceed 4 miles per hour.
3. Vibratory rollers shall be equipped with a variable amplitude and frequency system. The roller shall have vibratory drum with a minimum width of 60 inches. The vibrations of the drum shall be a minimum of 2000 vibrations per minute. The maximum rate of travel shall be 3 miles per hour.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify gradients and elevations of base are correct. Irregular surfaces of existing pavements or bases shall be brought to uniform grade and cross-section as directed.
- B. Verify aggregate base course are compacted per Section 321123 - Aggregate Base Courses.
- C. When specified in the Contract Documents, all longitudinal and traverse joints and cracks shall be sealed by the application of an approved joint sealing compound before the mixture is spread upon a pavement surface. All excessive bituminous material shall be removed from joints and cracks prior to placement of the mixture.

### 3.02 WEATHER LIMITATIONS

- A. The bottom lift of any bituminous material shall not be placed when the atmospheric temperature is less than 40°F and rising. The top lift of any bituminous material shall not be placed when the atmospheric temperature is less than 50°F and rising. The Architect/Engineer may require the Contractor to delay the application of bituminous material until the atmospheric and pavement surface conditions are satisfactory. No bituminous material shall be placed which cannot be cared for during daylight hours.

### 3.03 EQUIPMENT AND ORGANIZATION

- A. Each unit required in the execution of these Specifications shall be under the continuous supervision of a competent superintendent thoroughly experienced in this type of work. Experienced operators will be required on all equipment used in hauling and applying bituminous material and aggregates.
- B. All equipment necessary to perform this work properly shall be on the project, in proper working condition, and proved capable of by placing of test strips, whenever requested by the Architect/Engineer.

### 3.04 APPLICATION OF BITUMINOUS MATERIAL

- A. Bituminous material shall be applied upon the properly prepared surface at the rate and temperature specified using the pressure distributor to obtain uniform distribution at all points. To ensure proper drainage, the strips shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope. During all applications, the surfaces of manhole castings, valve boxes, and adjacent structures shall be protected in such manner as to prevent their being spattered or marred. Bituminous materials shall not be discharged into borrow pits, curb and gutter, or valley gutters. Any bituminous material discharged onto these areas shall be removed by the Contractor.

### 3.05 AGGREGATE BASE COURSE

- A. Aggregate base course shall be placed per Section 321123 - Aggregate Base Courses prior to performing any work specified in this Section.
- B. Aggregate shall be clean and dry for AC, MC & SS-1 applications. The surface on which pavement is to be placed shall be free of surface moisture or any condition that prevents proper handling, compaction, or finishing during the operating periods for the Contractor.

### 3.06 PRIME COAT

- A. Areas to be paved which are a 6% grade or greater, shall be primed prior to placing the first lift of asphalt pavement.
  - 1. The prime coat shall be applied only when the existing surface is dry, when the atmospheric temperature is 50°F and rising, and when the weather is not foggy or rainy.
  - 2. Immediately before applying the prime coat, the full width of surface to be treated shall be swept with a power broom and otherwise cleaned as necessary to remove all loose dirt and other objectionable material.
    - a. The application of bituminous material shall meet the requirements referenced in Subsection 2.1 of this Section.
    - b. Following the application, the surface shall be allowed to cure. This period may be modified by the Architect/Engineer depending upon job conditions. The Contractor shall not allow traffic on the bituminous material until it has been absorbed by the surface and will not pick up. The surface shall be maintained by the Contractor until the first paving lift has been placed. Suitable precautions shall be taken by the Contractor to protect the surface against damage during this interval, including any sand necessary to blot up excess bituminous material.
    - c. All fixtures in the areas to be overlaid shall be protected during paving operations.

### 3.07 TACK COAT

- A. The tack coat shall be applied between all lifts of asphalt and to all abutting pavement edges.
  - 1. The tack coat shall be applied only when the existing surface is dry, when the atmospheric temperature is above 40°F and rising, and when the weather is not foggy or rainy.
  - 2. Immediately before applying the tack coat, the full width of surface to be treated shall be swept with a power broom and otherwise cleaned as necessary to remove all loose dirt and other objectionable material. Unstable corrugated areas shall be removed and replaced with suitable patching materials. The edges of existing pavement and face of the curb and gutter which are to be adjacent to new pavement, shall be cleaned to permit the adhesion of bituminous materials.

- a. The application of bituminous material shall be made by means of a pressure distributor at the pressure and in the amount of 0.03-0.05 gallons per square yard of diluted material as directed by the Architect/Engineer. Maintain pressure so that the application rate varies no more than two-hundredth of a gallon per square yard (0.02 gallons/SY).
- b. Following the application, the surface shall be allowed to cure without being disturbed for such period of time as may be necessary to develop a tacky consistency. This period shall be determined by the Architect/Engineer. The area to which the tack coat is applied shall be no larger than can be paved during that day's work. The surface shall then be maintained by the Contractor until the next course has been placed. Suitable precautions shall be taken by the Contractor to protect the surface against damage during this interval, including any sand necessary to blot up excess bituminous material.
- c. All fixtures in the areas to be overlaid shall be protected during paving operations.

#### B. HOT PLANT BITUMINOUS PAVEMENT

1. The asphalt pavement shall be placed to the grades as shown in the Plans.
2. The maximum loading temperature for asphalt cements shall be 350°F, unless otherwise specified by the manufacturer.
3. Place the asphalt pavement only when the prime coat or tack coat has cured, when the weather is not rainy and when:
  - a. The atmospheric temperature is above 40°F and rising for the bottom lift of pavement.
  - b. The atmospheric temperature is above 50°F and rising for the top lift of pavement. No pavement shall be placed on frozen subbase.
4. Application:
  - a. Before laying the asphalt pavement, the underlying course shall be cleaned of all loose dirt, clay, or other objectionable material and the prime coat, or the tack coat is applied.
  - b. The mechanical spreader shall be adjusted and regulated so that the surface of the course will be smooth and of such depth that, when compacted, it will conform to the cross section, grade, and contour shown in the Plans.
  - c. Asphalt mixture that has a temperature of less than 250°F shall not be dumped into the mechanical spreader, unless otherwise specified by the manufacturer.
  - d. Unless otherwise directed, the placing shall begin along the low edge of areas to be paved.
  - e. The mixture shall be placed to minimize longitudinal joints.
  - f. Placing of the mixture shall be as nearly continuous as possible.
  - g. Contact surfaces or previously constructed curbs, and similar structures shall be painted with a thin coat of hot bituminous liquid prior to placing the bituminous mixture.
  - h. Each day's production shall be squared off for the entire width of the area paved in order to eliminate as many cool or cold longitudinal joints as possible, unless otherwise allowed by Architect/Engineer.
5. Compaction: After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Rolling of the mixture shall begin as soon as the material will bear the roller without undue displacement. Rolling shall commence on low side and continue to the higher side of mat being placed.
  - a. Cold longitudinal joints shall be kept to a minimum. These shall be tacked prior to installing adjacent materials.
  - b. Initial rolling shall be done longitudinally. The roller shall overlap on successive trips. Alternate trips by the roller shall be of slightly different lengths.

- c. Rolling shall continue until all roller marks are eliminated, the surface is of uniform texture and true to grade and cross section and a minimum of density of 92% of the maximum density as determined by Rice Test ASTM D2041/D2041M is achieved. Density shall be obtained prior to initial heat loss, and completed before the temperature of mat drops below 180°F, unless otherwise specified by the manufacturer. The Contractor shall work with the testing service to establish a rolling pattern that optimizes achieving proper density for the asphalt placement. Density at time of placement will be determined by the use of a properly calibrated Nuclear Density Gauge in accordance with ASTM D2950/D2950M.
  - d. To prevent adhesion of the mixture to the steel drum roller, the wheels shall be kept properly moistened, but excessive water will not be permitted.
  - e. In areas not accessible to the roller, the mixture shall be thoroughly compacted with mechanical plate compactors.
  - f. Any mixture that becomes loose and broken, mixed with dirt, or in any way defective shall be removed and replaced with fresh asphalt mixture and immediately compacted to conform to the surrounding area.
  - g. Any displacement occurring as a result of reversing of the direction of the roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care should be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.
6. Joints:
- a. General: The mixture at the joints shall comply with the surface requirements and present the same uniformity of texture, density, smoothness, etc., as other sections of the course. In the formation of all joints, provision shall be made for proper bond with the adjacent course for the specified depth of the course. Joints shall be formed by cutting back on the previous day's run to expose the full depth of the course; the exposed edge shall be given a light coat of asphalt. The fresh mixture shall be raked against the joint and thoroughly tamped and rolled.
  - b. Transverse: The placing of the course shall be as continuous as possible. The roller shall pass over the unprotected end of the freshly laid mixture only when discontinuing the laying of the course. Transverse joints shall be formed to ensure smoothness and optimum performance. Tack coat shall be applied prior to placing new mat adjacent to the transverse joint.
  - c. Longitudinal: The placing of the course shall be as specified and in such a manner that the joint is exposed for the shortest period possible. Tack coat shall be applied prior to placing new mat adjacent to the longitudinal joint.
7. Lift Thickness: The compacted lift thickness shall be between 1-1/2 and 2-1/2 inches. The total compacted lift thickness shall be within 1/4-inch of thickness, as shown in the Plans. A 3-inch lift (compacted thickness) may be allowed by the Architect/Engineer, if the Contractor can demonstrate he can construct it in compliance with these Specifications.
8. Smoothness Test: The finished surface shall not vary more than 3/16 inch when tested with a 10-foot straightedge applied both parallel with and at right angles to the centerline of the paved area. Irregularities that exceed the specified tolerance or that retains water when a water truck sprays water over the surface shall be corrected by removing the defective work and replacing with new material as directed by the Architect/Engineer and without additional cost to the Owner.
9. Against Concrete: Where asphalt is to be placed against concrete pavement, a joint sealer of polymer modified asphalt shall be applied to the concrete prior to placing the asphalt mixture. Asphalt shall extend above the lip of the curb but in no case extend above the lip of the curb by more than 1/2 inch. The crushed base shall allow placement of full depth of asphalt.

C. Recycled Asphalt Pavement (RAP)

1. Place the RAP to the lines and grades as shown in the construction documents. Compact the RAP course with two passes of a pneumatic tired roller followed by two passes of a vibratory smooth steel wheel roller operated in vibratory mode plus a fifth pass using the vibratory smooth steel roller in static mode. Do not exceed 8 inches for the maximum compacted thickness of any single layer. Apply water uniformly over the material during compaction to aid in proper consolidation.

### 3.08 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for quality control.
- B. Owner will engage a qualified testing laboratory acceptable to the Architect/Engineer for quality testing during construction per Section 014000 - Quality Requirements.
- C. Testing laboratory shall provide Architect/Engineer with copies of all test reports on a daily basis during paving operations and prior to the start of the next day's production.
- D. Sampling and testing for quality control during placement of asphalt will include the following, at a minimum but may include additional testing as determined by Architect/Engineer.
  1. Sampling: Sampling of the blended asphalt shall be performed in accordance with the ASTM D979 test method for sampling bituminous mixtures.
  2. Testing: Samples shall be taken for Aggregate Gradation, Asphalt Content, Marshall mixture properties and Mixture Density each day at the start of production and for every 1,000 tons of pavement placed per day.
    - a. The Marshall Test shall include the evaluation of stability, flow, percent air voids and voids in mineral aggregate (VMA). The Marshall Test shall be performed in accordance with ASTM D6926 and ASTM D6927. The mixture tests shall be performed on either plant samples or field samples.
    - b. The gradation tests shall be performed in accordance with the test methods described in the ASTM D5444 or the ASTM C117 and ASTM C136/C136M test methods. Plant samples for gradation tests may be taken every two (2) hours during production if directed by the Architect/Engineer.
    - c. Asphalt content shall be determined by either of the test methods ASTM D2172, ASTM D4125, or ASTM D6307.
    - d. Core Samples will be taken in accordance with ASTM D5361.
    - e. Maximum Density of the mixture will be determined in accordance with ASTM D2041/D2041M. The Maximum Density value will be used to calculate the percent (%) density.
    - f. Testing frequency and type may be modified by the Architect/Engineer.
- E. Failing Tests: When any test result is not in compliance with these Specifications, or if any Gradation or Asphalt Content Tests fail, then the Material Testing Lab or their field technician shall immediately notify the Architect/Engineer. The Architect/Engineer shall notify the Contractor of the noncompliance at which time the plant shall take the necessary steps to correct the asphalt mix. The Contractor shall make such modifications as required to ensure the in-place asphalt meets specification requirements. The modifications shall be approved by the Architect/Engineer, prior to implementation.
  1. Two additional samples for Marshall Tests, Gradation, and Asphalt Content Tests shall be taken at the next asphalt placement to determine if the asphalt mix is in compliance with Project Specifications. If any one, or more, of the additional Marshall, Gradation, or Asphalt Content Tests fail, the Contractor shall terminate production until the mix is corrected.



2. If the asphalt fails to meet its Marshall Test, Gradation, or Asphalt Content requirements, or if there are indications of deficient placement procedures, the Architect/Engineer, before final acceptance of the project, may request additional tests on the asphalt pavement. In the event that the additional tests indicate that the asphalt is unsatisfactory, the Contractor shall make such modifications as required to make the asphalt sound.
- F. The acceptable temperature range for Asphalt Pavement at the construction site shall be based on the Mix Design Criteria for that project. Asphalt arriving at the site unable to meet these temperature limitations will be rejected and the Contractor will be responsible for all replacement costs.
  - G. Pavement density will be determined by comparing the density of cores taken from the compacted pavement to the Maximum Theoretical Density determined by ASTM D2041/D2041M.
  - H. Prior to testing, the bulk specific gravity of the test specimen shall be measured in accordance with ASTM D2726 or ASTM D1188, whichever is applicable, for use in computing air voids and pavement density.
  - I. Core Density: Cores for determining the density of the compacted pavement shall be taken on a lot basis. The lot size shall consist of 200 tons, or as specified by the Architect/Engineer. One or more tests shall be made for each lot or fraction thereof, produced for each type of asphalt for each day, or partial day's production. One core shall be taken from each lot on a random basis in accordance with procedures contained in ASTM D3665. The density of each core shall be determined in accordance with ASTM D2726 or ASTM D1188, whichever is applicable.
  - J. Thickness: The in-place pavement will be accepted for thickness by measuring the cores taken for density. All core samples shall be measured and recorded to the nearest 1/8 inch.
    1. The thickness will be determined in accordance with ASTM D3549. The thickness shall be the average of the cores for that lot.
    2. If any core thickness test result indicates a thickness less than 1/4 inch of the design thickness, two (2) additional samples will be obtained from the lot using a random sample procedure. The additional cores shall be averaged to determine adequate or deficient depth of pavement per section. In the event a sample is obviously damaged, an alternate sample shall be taken within 10 feet of the location of the damaged sample.
  - K. All test holes shall be filled flush with approved hot plant mix bituminous pavement, or alternate material approved by the Architect/Engineer, and thoroughly compacted with methods approved by the Architect/Engineer within 48 hours. The surface of the fill shall not allow water to stand or enter the underlying layers.

### 3.09 PROTECTION

- A. After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until it has cooled to 140°F.

END OF SECTION 321216

## SECTION 321313 - CONCRETE PAVING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Concrete roadways, parking areas, and designated site concrete.

#### 1.02 RELATED REQUIREMENTS

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report, bore hole locations, findings of subsurface materials, and recommendations.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 033100 - Site Concrete Work
- D. Section 312201 - Grading
- E. Section 312323 - Fill
- F. Section 321123 - Aggregate Base Courses
- G. Section 321216 - Asphalt Paving
- H. Section 321723.13 - Painted Pavement Markings
- I. Section 330500 - Manholes

#### 1.03 REFERENCE STANDARDS

- A. AASHTO M 213 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- B. ACI 301 - Specifications for Structural Concrete.
- C. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide.
- D. ACI SPEC-301 - Specifications for Concrete Construction.
- E. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- F. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
- G. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- H. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
- I. ASTM C138/C138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
- J. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
- K. ASTM C150/C150M - Standard Specification for Portland Cement.

- L. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
- M. ASTM C231/C231M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- N. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
- O. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- P. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
- Q. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- R. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
- S. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- T. ASTM D994/D994M - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- U. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- V. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- W. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
- X. ASTM D5893/D5893M - Standard Specification for Cold-Applied, Single-Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
- Y. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

#### 1.04 SUBMITTALS

- A. Submittals shall be in accordance with these Specifications.
- B. See Section 013000 - Administrative Requirements, for submittal procedures.
- C. Concrete Mix Design: Concrete mix designs shall be prepared for each type of concrete by an independent testing laboratory acceptable to the Architect/Engineer. The mix designs shall be prepared in strict conformance with either the laboratory trial batch or field experience methods as defined by ACI SPEC-301. Subject to approval by Architect/Engineer this provision may be waived if the Contractor can show by previous testing and experience that the concrete will meet these Specifications. The concrete mix design submittal shall contain at a minimum the following information:
  - 1. A table showing weights of all aggregate, cement, water and admixtures to be used for a yard of concrete.
  - 2. The water-cement ratio, calculated from the weights of water and cementitious materials in the mix design.
  - 3. Certification of aggregate compliance with these Specifications and source of supply and location. Certification to include gradation tests, wear and soundness tests.
  - 4. Admixture literature to certify compliance with these Specifications.
  - 5. Cement Mill Test Certification.

- 6. Test reports indicating recent compressive and flexural strengths, air, and slump performance for the proposed mix.
- D. Samples: Submit samples of materials as specified and as otherwise requested by Architect/Engineer, including names, sources and descriptions.

## PART 2 PRODUCTS

### 2.01 PAVING ASSEMBLIES

- A. Comply with applicable requirements of ACI SPEC-301.
- B. Design paving for Light Duty and Heavy Duty rigid pavement sections as defined in the geotechnical report and as referenced in the Construction Documents.

### 2.02 FORM MATERIALS

- A. Form Materials: As specified in Section 033100 - Site Concrete Work, conform to ACI SPEC-301.

### 2.03 CONCRETE MATERIALS

- A. Portland Cement: Air entrained Portland Cement Concrete shall conform to the requirements of Section 033100 - Site Concrete Work.
- B. Normal Weight Concrete Aggregates: ASTM C33/C33M.
- C. Fly Ash: Fly ash shall be Class F conforming to ASTM C618.
- D. Water: Potable, clean and not detrimental to concrete.
- E. Admixtures: All admixtures to be used in concrete shall be subject to prior approval by the Architect/Engineer.
  - 1. Air-Entraining Admixture: ASTM C260/C260M.
  - 2. Water Reducing Admixture: ASTM C494/C494M Type A containing no more than 1% chloride ions.
  - 3. Calcium chloride is not permitted.

### 2.04 ACCESSORIES

- A. Joint Filler:
  - 1. Preformed joint filler shall conform to the requirements of AASHTO M 213, ASTM D994/D994M, ASTM D1751, or ASTM D1752 unless otherwise shown in the Plans, and shall be punched to admit the dowels where called for in the Plans.
  - 2. The filler for each joint shall be furnished in a single piece for the full depth required for the joint unless otherwise authorized by the Architect/Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape by stapling or other positive fastening satisfactory to the Architect/Engineer.
- B. Joint Sealers:
  - 1. A mastic joint sealer material of uniform, stiff consistency that does not contain solvents.
    - a. The mastic shall tenaciously adhere to primed concrete surfaces, shall remain permanently mastic and shall not contaminate potable water.

- b. The material shall be of a type that will effectively and permanently seal joints subject to movements in concrete.
  - 2. Hot poured sealer for joints shall conform to the requirements of ASTM D6690, unless otherwise shown in the Plans.
  - 3. Elastic joint sealer, where called for in the Plans, shall be two component polyurethane sealant meeting ASTM C920, Type M, Grade P, Class 25, Use TMO. Sealant for horizontal joints may be either Class A (self-leveling) or Class B (nonsag). Sealant for sloped or vertical joints shall be Class B.
  - 4. Silicone Rubber Base joint sealant shall conform to Federal Spec TT-S- 001543A Sealing Compound or ASTM D5893/D5893M.
  - 5. Preformed compression joints shall be manufactured to the size and shape shown in the Plans, from materials conforming to the requirements of ASTM D2628. The Contractor shall furnish a certification for each shipment indicating that the material has been sampled, tested, and inspected in accordance with the provisions of ASTM D2628. Each certification so furnished shall be signed by an authorized agent of the manufacturer or independent testing agency. If recommended by the manufacturer, an approved lubricant-adhesive may be used to provide lubrication and bond for the joint. The lubricant shall be manufactured of material that is compatible with the sealer.
- C. Curing Materials:
- 1. Liquid Membrane-Forming Compound: ASTM C309 Type 2, white pigmented.
  - 2. Waterproof Paper: ASTM C171.
  - 3. Burlap Cloth: AASHTO M182 Class 3.
- D. Tactile Warning Surfaces: See Section 321726 - Tactile Warning Surfacing.

## 2.05 CONCRETE MIX DESIGN

- A. The mix proportions will be based upon trial mixes conducted by an Independent Testing Laboratory in accordance with ACI PRC-211.1. The proportions will be stated in terms of aggregates in a saturated, surface-dry condition, and the batch weights will have to be adjusted periodically to take into account the actual moisture content of the aggregates at time of use.
- B. Design mix shall meet the Class A concrete classification detailed in 033100 - Site Concrete Work.

## 2.06 MIXING

- A. Concrete may be mixed at the site of construction or at a central point, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
- B. Central plant mixers shall be capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period.
- C. Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central mixed concrete shall conform to the requirements of ASTM C94/C94M.

- D. Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. The concrete shall be discharged from the bottom of the container. If discharge of concrete is accomplished by tilting the body, the surface of the load shall be retarded by a suitable baffle. Covers shall be provided when needed for protection.
- E. Ready-mix concrete shall be mixed and delivered in accordance with requirements of ASTM C685/C685M.

## 2.07 FINISHING MACHINES

- A. The finishing machine shall be of an approved type. The finishing machine shall be of ample weight and power for proper finishing of the concrete. The finishing machine shall be designed and operated to strike off, screed and consolidate the concrete. Screed and float adjustments of these machines shall be checked at the start of each day's paving. Machines that cause displacement of side forms or frequent delays due to mechanical failure shall be replaced. When the finishing machines ride the edge of previously constructed slabs, provisions shall be made to protect the surface of these slabs.

## 2.08 Vibrators, for full width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds.

- A. Vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage.
- B. Vibrators shall not come in contact with the joint, load transfer device, subgrade, or side forms.
- C. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute, and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.
- D. Sawing Equipment: The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water cooled diamond edge saw blade, abrasive wheel at the required rate or an early entry dry cut saw. The Contractor shall provide adequate artificial lighting for night sawing. All of this equipment shall be on the job before and continuously during concrete placement. A backup saw shall be available.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify gradients and elevations of base are correct.
- B. Verify aggregate base course are compacted per Section 321123 - Aggregate Base Courses.

### 3.02 PREPARATION

- A. The subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.
- B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.
- C. Notify Architect/Engineer minimum 24 hours prior to commencement of concreting operations.

- D. No concrete shall be placed on frozen ground.

### 3.03 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. The foundations under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact with its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting, as necessary.
- C. Forms shall be set sufficiently in advance of the point where concrete is being placed.
  - 1. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms.
  - 2. Forms shall be staked into place with not less than 3 pins for each 10 foot section. A pin shall be placed at each side of every joint.
  - 3. Formed sections shall be tightly locked, free from play or movement in any direction. No excessive settlement or springing of forms under the finishing machine will be tolerated.
  - 4. Forms shall be cleaned and oiled prior to the placing of the concrete.
- D. The forms shall not deviate from true line by more than 1/4 inch at any point. The alignment and grade elevation of the forms shall be checked, and corrections shall be made by the Contractor immediately before the concrete is placed. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.
- E. In lieu of setting forms the edge of a previously placed concrete and/or curb and gutter section may be used as a form.

### 3.04 MIXING CONCRETE

- A. When concrete is mixed in a central mixing plant, mixing time shall not be less than recommended by the manufacturer unless tests can show the mix can be thoroughly mixed in less time. Mixing time shall be measured from the time all materials, except water, are in the drum. Transfer time in multiple drum mixers is included in mixing time.
  - 1. The contents of an individual mixer drum shall be completely removed before a succeeding batch is emptied therein.
  - 2. The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer.
  - 3. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform, and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.
- B. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at their expense.
- C. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to ten percent above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and no spillage of concrete takes place.
- D. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed:

1. 45 minutes when the concrete is hauled in non-agitating trucks.
  2. 90 minutes when hauled in truck mixers or truck agitators.
- E. Re-tempering concrete by adding water or by other means will not be permitted, except that when concrete is delivered in transit mixers or agitators, and when approved by the Architect/Engineer. When additional water is added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, the following conditions must be met:
1. Water must be measured through a water meter.
  2. Maximum allowable water-cement ratio is not exceeded.
  3. Maximum allowable slump is not exceeded.
  4. Maximum allowable mixing and agitating time (on drum revolutions) are not exceeded.
  5. Concrete is remixed for at least half the minimum required mixing time or number of revolutions.
  6. Concrete that does not meet the above provisions shall be rejected.
- F. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.
- G. The temperature of the mixed concrete shall be not less than 50°F and not more than 90°F at the time of placing it in the forms.
1. The mixing water may be heated to no more than 150°F.
  2. Aggregate may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials.

### 3.05 PLACING CONCRETE

- A. The concrete shall be deposited on the grade in such manner as to require as little re-handling as possible. Unless truck mixers, truck agitators, or non-agitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.
- B. Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained 80% of design strength. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after 3 days.
- C. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or side form. In no case shall the vibrator be operated longer than 15 seconds in any one location.
- D. Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.



- E. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protection materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 2 inches and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the side of the pavement and covering the surface of the unhardened concrete with the protective covering.

### 3.06 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Joints shall be constructed of the type and dimensions, and at the locations required by the Plans.
- C. Bars shall be placed by approved mechanical equipment or rigidly secured by chairs and other approved supports to prevent displacement.
- D. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves.
- E. Dowels, when used as load transfer devices, shall be held in position parallel to the surface and centerline of the slab by a metal device that is left in the pavement.
  - 1. One half of each dowel shall be painted with one coat of lead or tar paint, to prevent the concrete from binding to that portion of the dowel.
  - 2. An approved metal dowel cap or sleeve shall be furnished for each dowel bar used with the expansion joints. The caps or sleeves shall fit the dowel bar tightly.
  - 3. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Architect/Engineer.
- F. Sawed joints shall be cut by means of concrete saws with diamond blades or other approved equipment to the depth, width, and line shown in the Plans.
  - 1. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing, and sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. Where the saw cut was discontinued because of interference of the form the saw cut must be completed when the form is stripped.
  - 2. Suitable guide lines or devices shall be used to assure cutting the joint as shown in the Plans.
  - 3. The saw cut shall not vary by more than 1/4 inch in 10 feet.
  - 4. When necessary, a second shallower cut must be made to provide adequate space for joint sealer. This sawing may commence as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing.
- G. When approved by the Architect/Engineer joints may be cut into the fresh concrete with a finishing tool. This tool must be capable of cutting to the depth specified.
  - 1. Suitable guide lines or devices shall be used to assure tooled joints are constructed as shown in the in the Plans.

2. The tooled joint shall not vary by more than 1/4-inch in 10 feet.
- H. Longitudinal Joints: Deformed steel tie bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints as shown in the Plans.
1. When adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint or dowels shall be installed at the spacing and size shown in the Plans. Tie bars or load transfer bars shall be installed through the holes in the forms or approved two-piece connectors may be used.
  2. Longitudinal contraction joints shall consist of planes of weakness created by cutting grooves in the surface of the pavement and, when shown in the Plans, shall include load transfer assemblies.
- I. Transverse Expansion Joints: The expansion joint shall be continuous from form to form, shaped to the subgrade.
1. The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete.
  2. Finished joints shall not deviate more than 1/4 inch in the horizontal alignment from a straight line.
  3. If joint fillers are assembled in section, there shall be no offsets between adjacent units.
  4. No plugs of concrete shall be permitted anywhere within the expansion space.
- J. Transverse Contraction Joints: Transverse contraction joints shall consist of planes of weakness created by cutting grooves in the surface of the pavement and, when shown in the Plans, shall include load transfer assemblies.
- K. Transverse Construction Joints: Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 5 feet of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 5 feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

### 3.07 FINAL STRIKE OFF, CONSOLIDATION, AND FINISHING

- A. The sequence of operations shall be the strike off and consolidation, floating and removal of laitance, straight edging, and final surface finish.
- B. First, the concrete shall be consolidated and struck off.
1. Unless otherwise permitted for small areas or for short periods of time due to equipment failure, all pavement concrete shall be consolidated using vibrators for full width of paving slabs.
  2. Concrete adjacent to joints shall be mechanically vibrated adjacent to the joints as required, the finishing machine shall be brought forward, operating in a manner to avoid damage to or misalignment of joint devices.
  3. After the concrete has been placed and vibrated adjacent to the joints as required, the finishing machine shall be brought forward, operating in a manner to avoid damage to or misalignment of joint devices
- C. After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated, by means of a longitudinal float, by the use of one of the following methods as specified or permitted:

1. Hand Method: The hand operated longitudinal float shall be not less than 12 feet in length and 6 inches in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion, while held in a floating position parallel to the road centerline, and shall be passed gradually from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.
  2. Mechanical Method: The mechanical longitudinal float shall be of a design approved by the Architect/Engineer and shall be in good working condition. The tracks from which the float operates shall be securely adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the Architect/Engineer on each transverse trip. The float shall pass over each area of pavement at least two times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.
  3. Alternative Mechanical Method: As an alternative to the Mechanical Method, the Contractor may use a machine composed of a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. This frame shall be carried by four or more visible wheels riding on, and constantly in contact with, the side forms.
  4. If necessary, following one of the preceding methods of floating, long handled floats having blades not less than 5 feet in length and 6 inches in width may be used to smooth and fill in open textured areas in the pavement. Long handled floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge ten feet or more in length. Successive drags shall be lapped one-half of the length of the blade.
- D. After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a 10 foot straightedge. For this purpose the Contractor shall furnish and use an accurate 10 foot straightedge swung from handles 3 feet longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other, as necessary. Advance along the road shall be in successive stages of not more than one-half ( $1/2$ ) the length of the straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to ensure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.
- E. The final finish shall be achieved by the following:

1. Bristle Broom: The surface texture produced by a broom shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping. The brooming operation shall be so executed that the corrugations produced in the surface shall be uniform in appearance and shall have a minimum depth of approximately 1/16 inch and a maximum depth of approximately 1/8 inch. Brooming shall be completed before the concrete is in such condition that the surface will be torn or unduly roughened by the operation. The finished surface shall be free from rough and porous areas, irregularities and depressions resulting from improper handling of the broom. Mechanical brooming, in lieu of the manual brooming, will be permitted if satisfactory results can be obtained.
  2. Transverse Tinning: The mainline finish shall be produced by mechanical equipment described as follows: The transverse grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb at the end of the pavement. Hand-grooving methods will be permitted in a manner approved by the Architect/Engineer in those areas where the mechanical equipment cannot be used.
    - a. This equipment shall have rectangular or circular shaped spring steel tines which are randomly spaced at 1/2 to 1 inch intervals from center to center. The grooves shall be made perpendicular to the center line of the pavement and the resulting transverse grooves shall be 0.090 to 0.125 inches wide and shall be 0.125 to 0.1875 inch deep.
- F. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to a radius of 1/4 inch.
1. A well defined and continuous radius shall be produced, and a smooth, dense mortar finish shall be obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.
  2. At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by texturing the surface. The rounding of all the corners of the slab shall not be disturbed when the surface is textured. All concrete on top of the joint filler shall be completely removed.
  3. All joints shall be tested with a straightedge before the concrete has set, and correction shall be made if one side of the joint is higher than the other or if an edge is higher or lower than the adjacent slabs.
- G. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.
- H. Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:
1. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.
  2. Narrow widths or areas of irregular dimensions where operations of the mechanical equipment are impractical may be finished by hand methods.
  3. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. In operation, the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.
  4. The screed for the surface shall be at least 2 feet longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed either of metal or other suitable material shod with metal.

5. Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

### 3.08 SURFACE TEST

- A. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 10 foot straightedge or other specified devices.
  1. Areas showing high spots of more than 1/4 inch, but not exceeding 1/2 inch in 10 feet, shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 1/4 inch when tested with a 10 foot straightedge. Grinders shall be of the stacked head, vertical blade type that will not polish or smooth the surface but will provide a coefficient of friction approximately equal to that of the unground pavement. Grinding grooves shall be kept parallel with the direction of travel.
  2. Where the departure from correct cross-section exceeds 1/2 inch, the pavement shall be removed and replaced by and at the expense of the Contractor. Any area or section so removed shall be not less than 5 feet in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 5 feet in length shall also be removed and replaced.

### 3.09 CURING

- A. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods.
  1. Cotton or Burlap Mats: The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighed down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for 72 hours after the concrete has been placed, unless otherwise specified.
  2. Waterproofed Paper: The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least 18 inches. The paper shall be so placed and weighed down as to cause it to remain in intimate contact with the surface covered. The paper shall be of such dimensions that each unit as laid will extend beyond the edges of the slab at twice the thickness of the pavement or shall be of pavement width and 2 foot strips of paper provided for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together, the joints being securely sealed in such a manner that they do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed. The surface of the pavement shall be thoroughly wetted prior to the placing of the paper.
  3. White Pigmented Impervious Membrane: The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with burlap or cotton mats, the curing compound may be applied upon removal of the mats.
    - a. The curing compound shall not be applied during rainfall.

- b. Curing compound shall be applied under pressure at a rate of approximately 1 gallon to 150 square feet by mechanical sprayers. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During the application the compound shall be stirred continuously by effective mechanical means. Hand spraying of off widths or shapes and on concrete surfaces exposed by the removal of forms will be permitted. Curing compound shall be applied to the inside faces of joints to be sealed.
  - c. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound.
  - d. Upon removal of side forms, the sides of the slabs exposed shall be protected immediately to provide a curing treatment equal to that provided for the surface.
- B. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period.
- C. When concrete is being placed and the average daily temperature is below 40°F or the air temperature may be expected to drop below 35°F, a suitable blanketing material shall be spread over the pavement to prevent freezing of the concrete. The period of time such protection shall be maintained shall be not less than 10 days or until the concrete has reached full strength. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the expense of the Contractor.

### 3.10 REMOVING FORMS

- A. Forms shall not be removed from freshly placed concrete until it has set for at least 12 hours, except auxiliary forms used temporarily in widened areas.
- B. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated above.
- C. Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than 5 feet in length nor less than full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 5 feet in length shall also be removed and replaced.

### 3.11 SEALING JOINTS

- A. When joints are specified to be sealed they shall be filled with joint sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible.
- B. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and the joint faces shall be clean and surface dry when the seal is applied.
- C. Material for seal shall be installed in accordance with the manufacturer's recommendations. A copy of the instructions shall be submitted to the Architect/Engineer for information.
- D. The sealing material shall be applied to each joint opening to conform with the Plans, or as directed by the Architect/Engineer.

- E. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed, and the pavement surface shall be cleaned. The use of sand or similar material as a cover for the seal will not be permitted.
- F. Poured joint sealing material shall not be placed when the air temperature in the shade is less than 50°F, unless approved by the Architect/Engineer.

### 3.12 TOLERANCE IN PAVEMENT THICKNESS

- A. The thickness of the pavement shall be determined by average caliper measurement of cores tested.
- B. A minimum of two cores will be taken for each 4,500 square yards of pavement. Small irregular unit areas may be included as part of another unit.
- C. When such measurement is deficient more than 0.2 inches and not more than 1.0 inch from the plan thickness, two additional cores at intervals not less than 100 feet will be taken and used in the average thickness for that unit.
- D. When the measurement of any core is less than the plan thickness by more than 1.0 inch, the actual thickness of the pavement in this area will be determined by taking additional cores at not less than 10 foot intervals parallel to the centerline in each direction from the affected location until in each direction a core is found which is not deficient by more than 1.0 inch. Areas found deficient in thickness by more than 1.0 inch shall be evaluated by the Architect/Engineer; if in their judgment the deficient area warrant removal, they shall be removed and replaced with concrete of the thickness shown in the Plans.

### 3.13 REPAIR OF DEFECTIVE PAVEMENT SLABS

- A. Spalls along joints shall be replaced by saw cutting at least 1/2 inch outside the spalled area and to a minimum of 2 inches. The area shall be chipped out at least 3 inches to solid concrete and then cleaned with compressed air sandblasting. First, the surface of the cavity shall be coated with an approved epoxy resin binder. Then the cavity shall be filled with an approved non-shrink grout.
- B. Random cracks which occur away from joints and, in the judgment of the Architect/Engineer, will not cause future maintenance problems may be routed and sealed. If not accepted, the slab shall be replaced at the expense of the Contractor.

### 3.14 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing laboratory acceptable to the Architect/Engineer for quality testing during construction per these Specifications.
- B. Testing laboratory shall provide Architect/Engineer with copies of all test reports on a daily basis during paving operations and prior to the start of the next day's production. All testing will be performed by an ACI certified technician.
- C. Sampling and testing for quality control during placement of concrete pavement will include the following, at a minimum but may include additional testing as determined by Architect/Engineer.
  - 1. Water-Cement Ratio: The actual water-cement ratio of the concrete, based on moisture content of aggregates and adjusted batch weights of water and cementitious materials, shall be determined and printed on the ticket of each load delivered to the jobsite.

2. Slump, Air Content, Temperature, and Unit Weight shall be performed on each days pour and each additional 25 cubic yards. Compressive Strength shall be performed on each day's pour and each additional 50 cubic yards thereafter.
  - a. Making and Curing Test Specimens in the Field: ASTM C31/C31M
  - b. Slump: ASTM C143/C143M
  - c. Air Content: ASTM C231/C231M for normal weight concrete; one for each set of compressive strength test specimens.
  - d. Concrete Temperature: Test hourly when air temperature is 40°F (4°C) and below, and when 80°F (27°F) and above; and each time a set of compression test specimens made.
  - e. Unit Weight: ASTM C138/C138M
  - f. Compressive Strength: ASTM C39/C39M
    - 1) One set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Hold and store cylinders or beams for laboratory cured test specimens except when field-cure test specimens are required.
    - 2) 1 specimen tested at 7 days, and 2 at 28 days with one held in reserve. Additional specimens may be required for field cure when conditions warrant.
    - 3) Strength level of concrete will be considered satisfactory if averages of sets of lab cured cylinders of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 10%.
    - 4) Test results shall be reported in writing to Architect/Engineer and Contractor as soon as possible. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for the 7-day, and 28-day tests.
  - g. All testing will be performed by an ACI certified technician.

### 3.15 PROTECTION

- A. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by their own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs and lights. The Contractor will be responsible to indicate the location and type of device or facility required to protect the work and provide adequately for traffic.
- B. Any damage to the pavement occurring prior to final acceptance or opening to traffic shall be repaired, or the pavement shall be replaced.

### 3.16 OPENING TO TRAFFIC

- A. The Architect/Engineer shall decide when the pavement shall be opened to traffic.
- B. Prior to being opened to traffic, the pavement shall be cleaned and all pavement markings shall be installed by the Contractor.

END OF SECTION 321313



## SECTION 321315 - CONCRETE MOW BANDS & HEADERS

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. The General Contract Conditions, Drawings, and Division - 1 Specification sections apply to Work of this section.

#### 1.02 SUMMARY

- A. Work Includes:
  - 1. Standard gray concrete mow band beneath fencing.
  - 2. Standard gray concrete for athletic equipment (flagpoles, netting foundations)
- B. Related Work:
  - 1. Division 31 – Section “Earthmoving”
  - 2. Division 32 – Section “Concrete Paving” by Civil
  - 3. Division 32 - Section “Concrete Paving Joint Systems” by Civil
  - 4. Division 32 – Section “Chain Link Fencing & Gates”
  - 5. Division 32 - Section “Flexible Paving” by Civil / Geotechnical Soils report

#### 1.03 SUBMITTALS

- B. In compliance with Paragraph 5.3.2 of ASTM C94, furnish statement of composition of concrete mix and admixtures and evidence that mix meets specified quality.
- C. Test reports as indicated below.
- D. Submit product data and Manufacturer's instructions for:
  - 1. Curing compounds.
  - 2. Concrete mix designs.

#### 1.04 REFERENCES

- A. Revised Subsurface Exploration & Geo-technical Engineering Report, prepared by Inberg-Miller Engineer's, Project #25054-LX, dated November 17, 2025
- B. American Concrete Institute:
  - 1. ACI 301 - Structural Concrete for Buildings
  - 2. ACI 305R - Hot Weather Concreting
  - 3. ACI 306R - Cold Weather Concreting
  - 4. ACI 316R - Recommendations for Construction of Concrete Pavements and Bases.

## 1.05 QUALITY ASSURANCE

- A. Testing Agency: The School District will engage a qualified independent engineering testing agency to perform field quality-control testing. Contractor shall contact the agency to arrange for testing at least forty-eight (48) hours prior to each pour.

## 1.06 PROJECT CONDITIONS

- A. Place concrete only when ambient air temperatures are above 45 degrees F and rising, unless it is protected from freezing. Do not place concrete on frozen ground.

## PART 2 - PRODUCTS

### 2.01 SUB GRADE MATERIAL

- A. Dense, readily compactable material, free from vegetable matter and lumps of clay. Material excavated from on-site that meets this requirement may be used if approved.

### 2.02 AGGREGATE BASE COURSE

- A. Aggregate base course as recommended in the geo-technical engineering report.

### 2.03 CONCRETE

- A. Materials: The concrete should be produced from an approved mix design as described in the Inberg-Miller Engineer's Revised Subsurface Exploration and Geo-technical Engineering Report-dated 11.17.25
- B. Manufacture and Delivery: Measurement of materials, batching, mixing, transporting, and delivery shall be as specified in ASTM C94. Discharge concrete into forms within 1-1/2 hours after introduction of water to cement. When temperature of concrete is 85 degrees F or above, the time between introduction of water to cement and complete discharge of concrete into forms shall not exceed forty-five (45) minutes.

### 2.04 EXPANSION JOINT FILLERS

- A. Pre-molded closed cell polyethylene foam, equal to "Sonoflex F" by Sonneborn, Minneapolis, Minnesota. Provide ½-inch thick by depth of the slab material, allow ½ thickness for joint sealer. See Section 321373 – Concrete Paving Joint Sealants.

### 2.05 EXPANSION JOINT SEALANT

- A. Shall be a silicone material that is on WYDOTs' approved silicone sealant list. See Civil 2512 - CCHS New High School Phase 3

## 2.06 CURING COMPOUND

- A. Curing Compound for Standard Grey Concrete: Clear Spray Applied Membrane Forming Liquid conforming to ASTM C309, Type 1. Prokrete Apromulsion @ 50A, white or acceptable substitution. Curing Compound shall not reduce bonding or adhesion of finish materials applied to concrete surfaces.

## 2.07 FORMS

- A. Wood, masonite or steel, profiled to site conditions.

## PART 3 - EXECUTION

### 3.01 PREPARATION OF SUB GRADE

- A. The subgrade should be carefully evaluated at the time of curbed or pavement construction for signs of disturbance or instability. All curbed or proposed pavement subgrades be thoroughly proof rolled to the satisfaction of the School District's 3<sup>rd</sup> party testing partner with a loaded tandem-axel dump truck prior to final grading. Improvement areas shall be moisture conditioned and properly compacted to the recommendations by the geo-technical engineer immediately prior to placing concrete or flexible paving section.
  - 1. Field Quality Control:
    - a. Special Inspections: The School District will engage a qualified special inspector to perform inspections.
    - b. Testing Agency: The School District will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
    - c. 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.
    - d. 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; re-compact and retest until specified compaction is obtained.

### 3.02 MAINTENANCE OF SUB GRADE

- A. Maintain sub grades in a compacted condition until concrete is placed.

### 3.03 FORMS

- A. Metal or uniform warp free lumber, coated with form release agent. Slope forms to give slabs

positive drainage and stake securely. Obtain approval of Owner's Representative for alignment and grade before placing concrete. Radii shall be continuous and flowing to avoid angular intersections in the horizontal alignment.

### 3.04 PLACING

- A. Concrete shall be formed, placed, vibrated and finished by hand using conventional methods. Concrete shall be placed at the line and grade shown on plans.
- B. Place concrete on moistened sub grade monolithically between construction joints. Deposit to full depth in one operation. Consolidate immediately. After depositing concrete, screed and darby or bullfloat.

### 3.05 CONCRETE FINISHING

- A. After darbying or bullfloating, stop finishing until bleeding has ceased and until concrete can support foot pressure with only about 1/8-inch indentation. During or after the first floating, check planeness of surface with a 10-foot straightedge applied at not less than two different angles, and then cut down all high spots and fill all low spots to achieve a true plane within 1/8 inch in 10 feet.
- B. Refloat slab immediately to a uniform sandy texture. Use steel trowel to densify surface, then apply medium broom finish to slab perpendicular to line of traffic if in pedestrian areas.

### 3.06 FORM REMOVAL

- A. Remove forms after concrete surface is hard enough so as not to be injured in any way. Reasonable care is to be used in removing forms. Repair minor defects with and sack rubbed finish. Plastering will not be permitted on exposed faces.

### 3.07 JOINTS

- A. Construct joints true to line with faces perpendicular to surface.
- B. Expansion Joints: Expansion joint material shall be provided at the following locations and shall be in place prior to the placing of concrete: 1) at each end of header return; 2) as shown on the plans, 3) if not indicated on the drawings, place expansion joints at a maximum of 100 feet.
  - 1. Thoroughly clean all surfaces prior to installation of caulking material.
- C. Header (Control) Joints: Space header joints not more than six-feet (6') on center or as indicated on the drawings / details. Contraction joints shall be tooled or saw cut. Form plane of weakness by inserting and later removing a metal divider, finish with an edger or groover, or by saw cutting a previously tooled joint.

### 3.08 CURING

- A. Thoroughly cure and protect concrete by keeping the surface moist for seven (7) calendar days or by use of curing compound applied in accordance with manufacturer's written instructions. Cure slabs with integral color in accordance with instructions of the pigment manufacturer using a pigmented membrane-forming curing compound with integral color to match concrete pigment. On exposed slabs with integral color, do not use polyethylene or paper sheeting.

### 3.09 FIELD QUALITY CONTROL

- A. Surfaces shall not vary more than 1/8-inch when tested with a ten-foot (10') straightedge.

### 3.10 PROTECTION

- A. Contractor shall be responsible for protecting the concrete flatwork until it is sufficiently hard. Concrete that is damaged by footprints, writing implements, or weather conditions is subject to replacement at no cost to the School District.

END OF SECTION

## SECTION 321500 - AGGREGATE SURFACING

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. The work of this section shall include excavation, compaction, import/installation and fine grading of various aggregate surfacing at the following locations indicated on the Drawings:
  - 1. Stabilized Crusher Fines over weed barrier.

#### 1.02 RELATED SECTIONS

- A. Division 32 – Concrete Pavements, Curb and Gutters.
- B. Division 32 - Section "Plants".
- C. Division 32 - Section "Turf and Grasses"

#### 1.03 SUBMITTALS

- A. Submit one (1) sample of each aggregate type that represents the full range of colors that can be expected. Submit one (1) gallon bag of specified material for review and approval.
- B. Sieve Analysis of "Crusher Fines" material.
- C. Weed Barrier Fabric.

#### 1.04 DELIVERY, STORAGE AND HANDLING

- A. Stockpile delivered material near path location.
- B. Material will be inspected upon delivery to site.
- C. Immediately remove unacceptable material from site.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Crusher Fines / Breeze – Stabilized
  - 1. Aggregate Size / Mix:
    - 1/4" minus crusher fines gravel - 2 parts
    - 3/16" crusher fines gravel - 1 part
    - 1-1/2" pit run (for installation as needed for soft or low spots) as / if needed
  - 2. Color: Grey
  - 3. Depth: Compacted Depth of 4"
- B. Soil Stabilized Binder:
  - 1. Manufactured by Stabilizer Solutions, Inc. 205 South 28<sup>th</sup> St., Phoenix, AZ 85034  
Ph: 602.225.5900 or 800.336.2468

2. Product: Non-toxic, organic binder that is a colorless and odorless concentrated powder that binds decomposed granite or crushed 3/8" or 1/4" minus aggregate.
- C. Weed Barrier Fabric – Made from non-woven polyester fibers mechanically bonded by needling. Fabric shall meet or exceed the following properties:

| <u>Property</u>                                                  | <u>Units</u> | <u>Method</u> |
|------------------------------------------------------------------|--------------|---------------|
| Grab Strength (min.)                                             | 90 lb        | ASTMD-4632    |
| Grab Elongation (min.)                                           | 70 lb        | ASTMD-4632    |
| Trapezoidal Tear Strength (min.)                                 | 40 lb        | ASTMD-4533    |
| Puncture Strength                                                | 50 lb        | ASTMD-3787    |
| Mullen Burst Strength                                            | 140 lb       | ASTMD-3786    |
| Submit sample and properties for approval prior to installation. |              |               |

### PART 3 - EXECUTION

#### 3.01 PLACEMENT

##### A. Crusher Fines Paving - Stabilized

1. Inspection
  - a. Visit site to determine existing conditions.
  - b. Grades: Verify that grades of area to receive stabilized crusher-fines are compliant with the grading plans.
2. Preparation
  - a. Utilities: Protect from damage of utilities in or near the project area.
  - b. General: Do not perform work when existing site conditions will not provide satisfactory results.
  - c. Clearing and Grubbing: Cut and remove woody or herbaceous vegetation within the path area. Haul debris off-site.
  - d. Compact subgrade with sheeps foot roller to 95% optimum density, in accordance with AASHTO T-99. Contractor is not required to scarify and re-compact the next 6" below this sub-grade level. Inspect exposed surface for unsuitable soil, areas of loose or soft soil, disturbed or moist soils. Remove soft, yielding subgrade material and backfill with 1 1/2" pit run.
  - e. Excavated sections and adjacent areas shall be reasonably smooth, compacted, and free from irregular surface changes.
3. Installation
  - a. Geo-textile Fabric:
    - 1) Overlap fabric edges a minimum of 6".

- 2) Lay in sections so that substantially all fabric is covered by gravel by day's end, minimizing exposure to sun and elements.
  - a) Owner's Representative will periodically inspect to assure approval of installation.
- b. Blending Stabilizer:
  - 1) Blend 12 to 16 lbs. (verify with Manufacturer for exact blend) of Stabilizer per 1-ton of decomposed granite or crushed 3/8" or 1/4" minus aggregate screenings. It is critical that Stabilizer be thoroughly and uniformly mixed throughout decomposed granite or crushed 1/4" or 3/8" minus aggregate screenings.
  - 2) Bucket blending is not acceptable. Blending with a rake and or shovel is not acceptable.
- c. Placement: After pre-blending, place the Stabilized aggregate materials on prepared sub-grade. Level to desired grade and cross section. Depth of installation as shown in the plans and details.
- d. Watering: Water heavily to achieve full depth moisture penetration of the Stabilized pathway profile. Water activates Stabilizer. To achieve saturation of Stabilized pathway profile, 25 to 45 gallons of water per 1-ton must be applied. During water application randomly test for depth using a probing device to the final depth.
- e. Compaction: Upon thorough moisture penetration, compact aggregate screenings to 85% relative compaction by compaction equipment such as; a 2 to 4-ton double drum roller or a 1,000 lb. single drum roller with vibratory plate tamp. Do not begin compaction for six-hours after placement and up to forty-eight (48) hours.
  - 1) Take care in compacting aggregate material when adjacent to planting and irrigation systems. Hand tamping with 8" or 10" hand tamp recommended.
- f. Inspection: Finished surface of stabilized crusher fines areas shall be smooth, uniform and solid. There shall be no evidence of chipping or cracking. Cured and compacted pathway shall be firm throughout profile with no spongy areas. Loose material shall not be present on the surface. Any significant irregularities in path surface shall be repaired to the uniformity of entire installation.
- g. Maintenance: If cracking occurs, simply sweep fines into the cracks, water thoroughly and hand tamp with a hand tamp plate.
- h. Repairs:
  - 1) Excavate damaged area to the depth of the Stabilized aggregate and square off sidewalls.
  - 2) If area is dry, moisten damaged portion lightly.



- 3) Pre-bend the dry required amount of Stabilizer powder with the proper amount of aggregate in a concrete mixer.
- 4) Add water to the pre-blended aggregate and Stabilizer. Thoroughly moisten mix with 25 to 45 gallons per 1-ton of pre-blended material or to approximately 10% moisture content.
- 5) Apply moistened pre-blended aggregate to excavated area to finish grade.
- 6) Compact with an 8" to 10" hand tamp or 250 to 300 pound roller. Keep traffic off areas for 12 to 48 hours after repair has been completed.

### 3.02 CLEAN UP

- A. General: Contractor shall be responsible for daily removal of mud and debris from road surfaces
  1. Remove unused stone and surfacing debris from the project site.
- B. Clean dirt, debris, trash and other deleterious material from stone surfaces and surrounding areas.

### 3.03 PROTECTION

- A. The Contractor shall be responsible for making a reasonable effort to protect the work from vandalism. Vandalism shall be brought to the attention of the General Contractor / Owner's Representative.

END OF SECTION

## SECTION 321723.13 - PAINTED PAVEMENT MARKINGS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, and curb markings.

#### 1.02 RELATED REQUIREMENTS

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 033100 - Site Concrete Work
- C. Section 321216 - Asphalt Paving
- D. Section 321313 - Concrete Paving
- E. Section 321726 - Tactile Warning Surfacing

#### 1.03 REFERENCE STANDARDS

- A. FHWA MUTCD - Manual on Uniform Traffic Control Devices.
- B. FS TT-B-1325 - Beads (Glass Spheres); Retro-Reflective.
- C. FS TT-P-1952 - Paint, Traffic Black, and Airfield Marking, Waterborne.
- D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association.

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.

#### 1.05 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.
  - 1. Parking Lots: Yellow.
  - 2. Handicapped Symbols: Blue.

- 3. Fire Lane Marking: White Symbols and Letters on Red Field.
- B. Reflective Glass Beads: FS TT-B-1325, Type I (low index of refraction), Gradation A (coarse, drop-on); with silicone or other suitable waterproofing coating to ensure free flow.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before proceeding.

### 3.02 PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean surfaces thoroughly prior to installation.
  - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

### 3.03 INSTALLATION

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 °F or more than 95°F.
- C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- D. Comply with FHWA MUTCD manual (<http://mutcd.fhwa.dot.gov>) for details not shown.
- E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
- F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.
  - 1. Apply paint in one coat only.
  - 2. Wet Film Thickness: 0.016 inch, minimum.
  - 3. Length Tolerance: Plus or minus 1 inch.
  - 4. Width Tolerance: Plus or minus 1/8 inch.
- G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
  - 1. Mark the International Handicapped Symbol at indicated parking spaces.

2. Hand application by pneumatic spray is acceptable.

- H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

#### 3.04 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
- E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved methods.
- F. Replace removed markings at no additional cost to Owner.

END OF SECTION 321723.13

## SECTION 321726 - TACTILE WARNING SURFACING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Tactile and detectable warning tiles for pedestrian walking surfaces.

#### 1.02 RELATED REQUIREMENTS

- A. Section 033100 - Site Concrete Work
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 321723.13 - Painted Pavement Markings

#### 1.03 REFERENCE STANDARDS

- A. 49 CFR 37 - Transportation Services for Individuals with Disabilities (ADA).
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
- C. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
- D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- E. ATBCB PROWAG - Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way.
- F. SAE AMS-STD-595 - Colors Used in Government Procurement.

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's product data, standard details, details specific to this project; written installation and maintenance instructions.

#### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years documented experience.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F.

### PART 2 PRODUCTS

#### 2.01 TACTILE AND DETECTABLE WARNING DEVICES

A. Cast Iron Detectable Warning Plates:

1. Material: Cast gray iron; ASTM A48/A48M, Class 30 A (minimum).
2. Installation Method: Cast in place.
3. Shape: Rectangular.
4. Dimensions: 24 inches x 48 inches.
5. Pattern: Truncated cones in compliance with ADA Standards.
6. Joint: Manufacturer standard, bolted connection.
7. Finish: Manufacturer's factory applied powder coat.
8. Color: SAE AMS-STD-595, Table IV, Brick Red No. 20109, or other approved contrasting color. Ensure detectable warnings provide a 70% light contrast against surrounding concrete surfaces.
9. Products:
  - a. Neenah Foundry, a division of Neenah Enterprises, Inc; Detectable Warning Plate (With Lugs).
  - b. Arcis Corporation - ADA Arcis Tactile Detectable Warning Panels.
  - c. East Jordan Iron Work, Inc. - Truncated Dome Detectable Warning Plates.
  - d. Meta Dome LLC - Metal Panel (Stainless Steel), Advantage Tactile Systems - Stainless Steel Tactile Unit
  - e. Or approved equal by the Owner.

2.02 ACCESSORIES

- A. Fasteners: ASTM A666/A666M, Type 304 stainless steel
1. Type: Countersunk, color matched composite sleeve anchors
  2. Size: 1/4 inch diameter and 1-1/2 inches long.
- B. Adhesive: Type recommended and approved by surfacing tile manufacturer.
- C. Sealant: Elastomeric sealant of color to match adjacent surfaces; approved by surfacing tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work area is ready to receive work:
1. If existing conditions are not as required to properly complete the work of this section, notify Architect/Engineer.
  2. Do not proceed with installation until deficiencies in existing conditions have been corrected.
- B. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.02 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's written instructions.
1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
  2. Do not install when ambient or substrate temperature has been below 40 degrees F during the preceding 8 daylight hours, or in contradiction to manufacturer's installation guidelines.
- B. Field Adjustment:

1. Locate relative to curb line in compliance with ATBCB PROWAG, Sections 304 and 305.
  2. Orient so dome pattern is aligned with the direction of ramp.
- C. Construct units to neat lines and grades. Install units fully seated to substrate, square to straight edges and flat to required slope.
- D. Align units so that tops of adjacent units are flush and joints between units are uniform in width.
- E. Avoid crossing concrete joints. Where crossing of joints cannot be avoided, custom cut detectable warning material across the joint line so the joint can work without tearing the detectable warning material.
- F. Make the valleys of the detectable warning material flush with the adjacent pavement.
- G. Replace any treatments which fail to fully bond to adjacent surfaces.
- 3.03 INSTALLATION - CAST IN PLACE, CAST IRON PLATES
- A. Install by method described in manufacturer's written instructions.
- B. Place units into wet concrete.
- C. Press assembly into concrete to achieve final elevation.
- D. Finish concrete adjacent to plate. Remove wet concrete spilled onto plate surface.
- 3.04 PROTECTION
- A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
- B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

**END OF SECTION 321726**

## **SECTION 02920**

### **IRRIGATION**

#### **PART 1 GENERAL**

##### **1.01 SCOPE**

- A. Provide labor, materials, supplies, equipment, tools, transportation and perform all operations in connection with and reasonably incidental to the complete installation of the irrigation system; and guarantee/warranty as shown on the drawings, installation details and as specified herein.

##### **1.02 SUBMITTALS**

- A. The Contractor shall submit one (1) PDF copy of all submittals to the Project Engineer prior to the commencement of the work.
  - 1. Provide a table of contents and index
    - a. Unless otherwise provided for in the contract documents, index shall be organized into sections based on pay items provided in Method of Measurement and Basis of Payment (see Part 4 below).
    - b. Index for each section must show the specific components and model numbers being provided for that section.
    - c. If components or items apply to multiple Method of Measurement and Basis of Payment sections, the components shall be shown or listed in all applicable sections of the index. However, cut sheets need only be supplied once at the first applicable Section.
  - 2. Submittals must be made of all the components on the material list. Additional components may be necessary due to Special Provisions. Such Special Provision items shall be indicated as such in the index by their respective Special Provision numbers.
  - 3. Highlight, or otherwise clearly indicate, which items are being supplied on catalog cut sheets. Also highlight, or otherwise clearly indicate, options as there may be for any given item.
  - 4. Submittal package (including table of contents and index) must be complete prior to being reviewed by the Project Engineer. Incomplete submittals may be returned without review at the option of the Project Engineer.
- B. Materials List: Include sprinklers, bubblers, pipe, sleeving, controller, communication system, valves, valve boxes, meters, hydrometers, wire, wire connectors, gate valves, fittings, solvents, cements, air relief valves, conduit, shop drawings and all other components shown on the drawings and installation details and/or as described in these specifications for any pay item applicable to the work. Components such as pipe sealant, pipe solvent cements, wire, wire connectors, ID Tags must be included. Quantities of materials need not be included.
- C. Manufacturers Data: Submit manufacturers' catalog cuts, specification and operating instruction for equipment shown on the materials list. For sprinklers, bubblers and other



end-point irrigation water delivery devices, head performance data and/or charts must be provided.

- D. Shop Drawings: Submit shop drawings as called for in the installation details, design drawings and/or contract documents. Show products required for proper installation, their relative locations and critical dimensions. Note modifications to the installation detail if applicable.

### **1.03**

#### **RULES AND REGULATIONS**

- A. Provide work and materials in accordance with latest edition of National Electric Code, Uniform Plumbing Code as published by the Western Plumbing Officials Association, and applicable laws, regulations and codes of governing authorities.
- B. When contract documents call for materials or construction of better quality or larger size than required by above-mentioned rules and regulations, provide quality and size required by contract documents.
- C. If quantities are furnished either in specification or on drawings, quantities are furnished for information only and are understood to be estimates. It is Contractor's responsibility to determine actual quantities of material, equipment and supplies required by the project and to complete independent estimates of quantities and wastage.
- D. Notify Owner's Representative in writing prior to construction about any discrepancies between contract documents and existing site conditions or manufactures specific recommendation for use of their product.
- E. Contractor is responsible for damage to existing site amenities, features, fixtures and appurtenances during construction. Replace damaged items with identical material of equal value to match conditions prior to construction. Make replacements at no additional cost to the contract price. Penalty for any specific damage shall be on the basis of the value determined by an independent auditor or as mutually agreed to by Owner and Contractor in writing.

### **1.04**

#### **QUALITY ASSURANCE**

- A. Engage an experienced Installer who has completed irrigation work similar in material, design and extent to that indicated by the contract documents and with a record of successful irrigation installations.
  - 1. Installer's Field Supervision: Installer shall have their Onsite Supervisor (or Foreman); a person with a minimum of three (3) years' experience installing projects of similar size and scope. This person shall be on the project site full-time when irrigation installation activities are in progress. The onsite supervisor will be designated at the Pre-Construction conference.
- B. Additional qualifications, experience, references and documentation may be required by special provision.

## 1.05

## TESTING

- A. Except as specifically provided for in Part 4 or by Special Provision, all testing described herein shall be considered incidental to the completion of the work and no separate payment shall be made for the completion of testing or retesting.
- B. Schedule testing with Engineer and Owner's Representative a minimum of three (3) days in advance of testing.
- C. Mainline pipe jointed with rubber gaskets or threaded connections may be subjected to pressure test at any time after partial completion of backfill. Allow irrigation pipe jointed with solvent welded PVC joints to cure at least twenty-four (24) hours before testing.
- D. Subsection(s) of mainline pipe may be tested independently, subject to review and approval of Engineer.
- E. Provide clean, clear water, pumps, tools, instruments, labor, fittings and equipment necessary to conduct tests or retests.
- F. Testing Documentation
  - 1. Submit a written report of all tests to Owner and Engineer. Each test report shall provide:
    - a. Test type or name
    - b. Date of test
    - c. Name of individual(s) performing the test on behalf of Contractor
    - d. Name of subcontractor or company performing the test on behalf of Contractor
    - e. Test results as appropriate and required for the test being performed
    - f. Hydrostatic Pressure Tests and Volumetric Pressure Tests shall clearly indicate the section(s) of mainline being tested.
- G. Hydrostatic Pressure Test
  - 1. Hydrostatic pressure test to be conducted for all mainline pipe.
  - 2. Subject mainline pipe to hydrostatic pressure equal to 140 psi for two (2) full hours.
  - 3. All mainline components must be installed for the mainline section to be tested. All RCV's and/or RCV Isolation Valves installed on the mainline section shall be in a MANUALLY CLOSED position.
  - 4. Backfill trenches sufficient to prevent pipe movement under pressure. Expose couplings, fittings, changes in direction and mainline components.
  - 5. Purge air from mainline pipe before test. Attach pressure gauge to mainline pipe in test section.
  - 6. Observe pressure loss on pressure gauge. If pressure loss is greater than five (5) psi, identify reason for pressure loss. Replace defective pipe(s), fitting(s), joint(s), valve(s) or appurtenance(s) as necessary. Make replacements at no

additional cost to Owner. Repeat test until pressure loss is equal to or less than five (5) psi.

7. Visually inspect irrigation pipe for leakage and replace defective pipe(s), fitting(s), joint valve(s) or appurtenance(s). Repeat test until pipe passes test.
8. Cementing, cement or concrete encasement, caulking, taping, heating or any similar methods to seal leaks is prohibited.
9. Repeat test(s) until entire mainline passes all tests. Repeat tests, replace components, appurtenances and correct deficiencies at no additional cost to Owner.

H. Volumetric Leakage Test

1. Shall only be performed by approval of Engineer on mainline sections greater than or equal to three (3) inches in diameter if mainline section does not pass the Hydrostatic Pressure Test.
2. All mainline components must be installed for the mainline section to be tested. All RCV's and/or RCV Isolation Valves installed on the mainline section shall be in a MANUALLY CLOSED position.
3. Backfill trenches sufficient to prevent pipe movement under pressure. Expose couplings, fittings, changes in direction and mainline components.
4. Purge air from mainline pipe before test. Attach pressure gauge to mainline pipe in test section.
5. Provide all necessary pumps, bypass piping, storage tanks, meter, 3-inch test gauge, supply piping, fittings and all other necessary tools, equipment and materials in order to properly perform testing.
6. Testing pump must provide minimum continuous 140 psi of pressure to the mainline pipe for a period of two (2) full hours. Test pressure shall not deviate by more than five (5) psi during test period. Restore test pressure to 140 psi at conclusion of test period.
7. Water added to mainline pipe must be measured volumetrically to nearest tenth (0.10) gallon.
8. Allowable maximum volume loss during test shall be calculated according to the following method and table:

a. Allowable Leakage (Gallons per (100 Joints)/Hour)

| PIPE SIZE<br>(INCHES) | Test Pressure (psi) |      |      |      |      |      |      |      |      |
|-----------------------|---------------------|------|------|------|------|------|------|------|------|
|                       | 60                  | 70   | 80   | 90   | 100  | 110  | 120  | 130  | 140  |
| 3"                    | 0.31                | 0.34 | 0.36 | 0.38 | 0.41 | 0.43 | 0.44 | 0.46 | 0.48 |
| 4"                    | 0.42                | 0.45 | 0.48 | 0.51 | 0.54 | 0.57 | 0.59 | 0.62 | 0.64 |
| 6"                    | 0.63                | 0.68 | 0.73 | 0.77 | 0.81 | 0.85 | 0.89 | 0.92 | 0.96 |
| 8"                    | 0.84                | 0.90 | 0.97 | 1.03 | 1.08 | 1.13 | 1.18 | 1.23 | 1.28 |

Note: Allowable Leakage Formula  $L = (ND\sqrt{P})/7400$  where:

L = Allowable Leakage per Hour (gph)

N=Number of Joints within Mainline Section

STANDARD CONSTRUCTION SPECIFICATIONS

Section 02920 - Irrigation

D=Nominal Diameter of Pipe (inches)

P=Average Test Pressure (psi)

9. Replace defective pipe(s), fitting(s), joint(s), valve(s) or appurtenance(s) as necessary at no additional cost to Owner. Repeat test(s) until entire mainline passes test.
10. Cementing, cement or concrete encasement, caulking, taping, heating or any similar methods to seal leaks is prohibited.
11. Contractor may sub-contract testing as approved by Engineer and Owner.
12. Repeat test(s) until entire mainline passes all tests. Repeat tests, replace components, appurtenances and correct deficiencies at no additional cost to Owner.

I. Operational Test

1. Charge POC Assembly and Mainline. Ensure all air is evacuated from POC Assembly and Mainline.
2. Activate and fully cycle each Remote-Control Valve (RCV) in sequence from controller. Sequencing may be non-linear; provided each and every RCV is fully cycled at least once.
  - a. If controller is remote capable, valve activation must be remote. If controller is not remote capable, provide one (1) additional personnel to operate controller to activate and fully cycle each and every RCV from controller while Contractor and Owner's Representative observe system operation.
3. Manual operation of an RCV using manual bleed mechanism of any kind at RCV is not an acceptable method of testing.
4. Owner's Representative will directly observe operation, water application patterns, leakage and valve cycling. Operational Testing without an Owner's Representative present shall not be accepted.
5. Replace defective RCV's, solenoids, wiring or other appurtenances as necessary to correct operational deficiencies.
6. Replace, adjust or move water emission devices to correct operation or coverage deficiencies. Refer to contract documents and/or design drawings for minimum coverage efficiency requirements.
7. Replace defective pipe, fittings, joints, valves, sprinklers or other appurtenances to correct leakage problems. Cementing, cement or concrete encasement, caulking, taping, heating or other similar methods to seal leaks are prohibited.
8. Repeat test(s) until each and every RCV and its connected lateral line passes all tests. Repeat tests, replace components, appurtenances and correct deficiencies at no additional cost to Owner.

J. Copper Tracing Wire

1. Using an underground utility locate device approved by Engineer, demonstrate that wire is capable of locating entirety of mainline pipe.
2. If wire is not capable of locating entirety of mainline pipe, locate break or deficiency in tracing wire and replace wire section, splice or defect as indicated.
3. Repeat test(s) until entire mainline can be located with tracing wire per its intended use.

K. Control System Grounding

1. Test for proper grounding of control system per manufacturer's recommendations and requirements. Test results must meet or exceed manufacturer's guidelines for acceptance.
2. Replace defective wire, grounding rod or other appurtenances as necessary. Repeat test(s) until the manufacturer's guidelines are met. Make such replacements as required at no additional cost to Owner.

L. Compaction Testing

1. Unless specifically provided for in these specifications or by the contract documents, the minimum compaction result of any compaction test referred to herein shall be ninety-five percent (95%) of Standard Proctor Density, ATSM D689-78.
2. Compaction Testing at POC Assembly: Contractor shall be required to hire an independent certified testing agency as approved by the Engineer to provide compaction testing at the POC Assembly.
  - a. Requirements and Frequency
    - i. A minimum of three (3) compaction tests shall be required at the POC Assembly
      - I. At two (2) feet of cover around and above the upstream connection to the vertical riser pipe out of the Meter Vault to above grade POC components: Contractor shall bed, backfill and compact to two (2) feet of cover over all horizontally installed pipe and fitting and provide a compaction test.
      - II. At surface grade around Vertical Riser Pipe out of Meter Vault: Contractor shall backfill and compact to not less than six (6) inches but not more than two (2) inches below finished grade and provide a compaction test.
      - III. At surface grade around downstream vertical riser pipe from above grade POC components to connection with existing irrigation mainline: Contractor shall bed, backfill and compact to not less than six (6) but not more than two (2) inches below finished grade and provide a compaction test.

3. Mainline Trench Backfill Compaction Testing: As indicated in design drawings and/or contract documents.
  4. Compaction Testing at Sleeves: As indicated in design drawings and/or contract documents.
- M. Testing Review: Failure of initial testing review will require additional review. Payment of costs, including travel expenses and site visit by Engineer and/or Owner's Representative, for additional reviews as may be required due to non-compliance with these specifications and/or the contract documents will be at the expense of the Contractor.

## **1.06 CONSTRUCTION REVIEW**

- A. The purpose of on-site construction reviews by Owner's Representative is to periodically observe work in progress, Contractor's interpretation of construction documents and to address questions with regard to installation.
1. Schedule review for irrigation system layout or testing with Engineer and/or Owner's Representative as required by these specifications and/or the contract documents.
  2. Impromptu review may occur at any time during the installation of the project.
  3. A review will occur at completion of irrigation system installation and Project record Drawing submittal.

## **1.07 GUARANTEE/WARRANTY AND REPLACEMENT**

- A. The purpose of guarantee/warranty is to ensure that Owner receives irrigation materials and workmanship of prime quality, installed in a thorough and careful manner.
- B. For a period of One Year from the date the project improvements are formally accepted by Owner, Contractor shall warranty irrigation materials, equipment and workmanship against defects. Restore landscape or structural features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by defective item(s). Contractor shall make repairs within thirty (30) days of notification by the Owner's Representative.
- C. Contract documents govern replacements identically as with new work. Make replacements and correct deficiencies at no additional cost to the Owner.
- D. Guarantee/warranty applies to both originally installed and replaced materials and equipment during the guarantee/warranty period.

## **PART 2 MATERIALS**

### **2.01 QUALITY**

- A. Use new materials without flaws or defects of any type and which are the best of their class and kind.

### **2.02 SUBSTITUTIONS**

- A. Alternative equipment must be approved by the Owner and Engineer prior to bidding per the policies and procedures provided for in the Instructions to Bidders. The Contractor is responsible for making any changes to the design to accommodate alternative equipment.
- B. Pipe sizes referenced in the construction documents are minimum sizes and may be increased at the option of the Contractor with approval of the Engineer at no additional cost to the Owner.

### **2.03 SLEEVING**

- A. Install separate sleeves for control and communication wires (min 2" diameter). Wire sleeves must be separate from pipe sleeves. Wire sleeves shall not be routed inside pipe sleeves.
- B. Sleeves shall be installed under all paved surfaces whether indicated on the plan or not.
- C. Extend all sleeves twelve inches (12") past any pavement edge.
- D. Sleeve sizes for solvent weld pipe shall be two times (2X) the size of the pipe being run through the sleeve. Sleeve diameter for gasketed pipe must accommodate outside diameter of joint-restraint casing spacers (refer to joint restraint manufacturer's sizing recommendations).
- E. All sleeves shall be a minimum of Schedule 40 PVC.
- F. When sleeves are installed and irrigation pipe or wire is not run through said sleeves, the end of the unused sleeve shall be completely sealed so as to prevent intrusion of soil and water. End of sleeve shall be marked with a 2 x 4 stake brought to the surface. Any concrete being placed over unused sleeves shall be marked with a three inch (3") "SLV" stamp to indicate sleeve location. Each individual sleeve shall be stamped, multiple sleeves shall not be marked with a single stamp. Such unused sleeves shall be extended eighteen inches (18") past any pavement edges.

### **2.04 PIPE AND FITTINGS**

- A. PVC Mainline Pipe and Fittings
  - 1. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with integral belled end.
  - 2. Use Class 200, SDR-21, rated at 200 PSI, conforming to dimensions and tolerances established by ASTM Standard D2241.

3. For Direct Bury Mainlines of nominal pipe diameter of greater than or equal to three inches (3"): Use rubber-gasketed pipe equipped with factory installed reinforced gaskets for mainline pipe. Use Gasketed pipe joints conforming to "Laboratory Qualifying Tests" section of ASTM D3139. Use gasket material conforming to ASTM F477. Use lubricant approved by pipe and fitting manufacturers.
4. For Direct Bury Mainlines of nominal pipe diameter less than three inches (3"): Use Schedule 40 solvent weld pipe. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784. Use primer approved by pipe manufacturer. Clear primers shall not be used. Use solvent cement conforming to ASTM Standard D2564 and these specifications.
5. Mainline pipe within sleeves: Use solvent weld pipe for mainline pipe with nominal diameter 3- inches and smaller installed within sleeves. Use pipe equipped with factory installed reinforced gaskets for mainline pipe with nominal diameter of 4-inches and larger installed within sleeves. Provide restrained casing spacers where gasketed joints occur within sleeve.
6. PVC Fittings General: Use minimum Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784. Use primer approved by pipe manufacturer and these specifications. Clear primers shall not be used. Use solvent cement conforming to ASTM Standard D2564.
  - a. PVC Cross type fittings shall not be used.
  - b. PVC expansion fittings (aka "Flow-Spans") and PVC Compression fittings shall not be used.

**B. HDPE Mainline Pipe and Fittings**

1. Use high density, extra high molecular weight polyethylene pipe (HDPE), extruded from material meeting the specifications of cell classification on PE 4710, ASTM standard D 3350, SDR 11, rated at 200 PSI, conforming to the dimensions and tolerances established by ASTM F 714 for mainline pipe.
2. Join pipe lengths using butt-fusion technique as recommended by pipe manufacturer.
3. The following are acceptable methods to join HDPE pipe to dissimilar materials:
  - a. MNPT (316 Stainless) x Butt Fusion
  - b. IPS Spigot x Butt Fusion, with Pipe Stiffener and Joint Restrained Gasketed DI Coupling and necessary restraining harness conforming to these specifications for DI Fittings and joint restraint harnesses.
  - c. Flange x Butt Fusion, with ductile iron backup ring.

**C. Lateral Pipe and Fittings**

1. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with integral belled end suitable for solvent welding.



2. Use minimum Schedule 40 conforming to dimensions and tolerances established by ASTM Standard D1785; UV radiation resistant. Class 200 PVC shall not be used for lateral pipe.
3. Use solvent weld pipe for lateral pipe. Use UV radiation resistant Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by pipe manufacturer and these specifications. Clear primers shall not be used. Use solvent cement to conform to ASTM Standard D2564, of type approved by pipe manufacturer and these specifications.

D. Specialized Pipe, Fittings, Sealants and Solvent Cements

1. Copper Pipe: Use Type “K” rigid pipe conforming to ASTM Standard B88.
2. Flexible HDPE Service Pipe: Use minimum SDR9 CTS pipe rated to minimum 200 PSI per ASTM D2737 and meets requirements of AWWA C901 and ANSI 61-G.
3. Copper, Brass and Bronze Fittings:
  - a. Copper and Brass Press to Connect Fittings: Shall be compatible with ASTM B88 and conform to ANSI 372. May be installed above or below grade as presented in installation details and construction drawings.
  - b. Bronze Fittings: Shall conform to ASTM B62, UNS C83600, ANSI B16.16 and ANSI B1.20.1.
  - c. Brass Fittings: Use lead-free seamless red brass nipples conforming to ASTM B43-09 and UNS C23000. Use lead free brass fittings and valves conforming to ANSI 372.
4. Ductile Iron (DI) Pipe: Use Class 50 conforming to ANSI A21.51 (AWWA C151). Use minimum of Class 53 thickness pipe for flanged piping. All ductile iron pipe installed below grade shall be red-prime coated or as presented in construction drawings, details and contract documents. Construction drawings, details and contract documents may call for 6-mil polyethylene film per AWWA C105 in certain situations, refer to contract documents.
5. Use mechanical joints conforming to ANSI A 21.10 (AWWA C110) and ANSI A21.11 (AWWA C111) or flanged fittings conforming to ANSI/AWWA C110 and ANSI B16.1 (125#).
6. Use dielectric union wherever non-ferrous materials (copper, brass, bronze) are joined to ferrous materials (iron, galvanized steel, stainless steel).
7. Low Density Polyethylene Hose:
  - a. Use pipe specifically intended for use as flexible swing joint.  
Inside diameter: 0.490+0.010 inch.  
Wall thickness: 0.100+0.010 inch.  
Color: Black.
  - b. Use spiral barb fittings supplied by same manufacturer as hose.
8. Use stainless steel fasteners and rubber gaskets for flanged connections.

9. Use PVC Schedule 80 nipples and PVC Schedule 40 threaded fittings for threaded pipe connections.
  - a. When transitioning from DI threaded pipe to PVC threaded pipe, use only PVC MIPT fittings into DI FIPT fittings. Do not use PVC FIPT over DI MIPT.
10. Joint sealant: Use non-hardening, nontoxic pipe thread sealant formulated for use on threaded connections and approved by pipe fitting or valve manufacturer.
11. PVC Primers and Solvent Cements
  - a. Use purple primer and heavy-set (aka “Gold”) solvent cements. Use solvent cement conforming to ASTM Standard D2564. Clear primers and “hot-set” or “quick-set” cements shall not be used.

E. Joint Restraint Harness

1. Provide joint restraint harness components as recommended by pipe and fitting manufacturer and in accordance with accepted industry practices. For joint restraints on ductile iron pipe applications, use restraint components constructed of 60-42-10 ductile iron conforming to ASTM A536. For joint restraints on PVC pipe applications, use restraint components constructed of 60-42-10 ductile iron conforming to ASTM A536-80 and ASTM F1674-96.
2. Use bolts, nuts, retaining clamps, all-thread, or other joint restraint harness materials which are stainless steel, zinc plated, galvanized or epoxy coated. Field application of epoxy coatings to such components shall be permitted.
3. Restrained Casing Spacers: Provide Ford Uni-Flange Restrained Casings Spacers or equal. Use restrainer body and runner supports constructed of high strength ductile iron meeting ASTM A536 and grade 65-42-12. Use Connecting rods conforming to ASTM A242, ANSI/AWWA C111/A21.11. Use runners constructed of ultra high molecular weight polymer.

F. Ductile Iron (DI) Fittings

1. All ductile iron fittings shall be fusion bond epoxy coated per AWWA C116 except as indicated in construction drawings, details or as approved by Engineer.
  - a. Materials with damaged or chipped epoxy coating shall not be acceptable and must be immediately removed from the job site.
  - b. Use bolts, nuts, retaining clamps, all-thread, or other hardware which are stainless steel, zinc plated, galvanized or epoxy coated. Field application of epoxy coatings to such components shall be permitted.
2. Ductile Iron Flanged Fittings
  - a. Use Class 50 conforming to ANSI A21.51 (AWWA C151). Use minimum of Class 53 thickness pipe for flanged piping.
3. Ductile Iron IPS Gasketed Fittings:
  - a. Shall be manufactured of Grade 65-45-12 ductile iron in accordance with ATSM A536.

- b. Fittings shall have deep bell, push-on ends with gaskets meeting ATSM F477.
- c. Fitting to pipe restraints shall:
  - i. Meet the requirements of UNI-B-13-94. Grip ring serrations shall be machined. Cast serrations shall not be permitted. Restraint rods, bolts and nuts shall be of ductile iron conforming to ASTM A563 or low alloy steel to ANSI A21.11 (AWWA C111)
  - OR—
  - ii. Shall be knuckle style composed of a one-piece grip ring residing within a ductile iron housing having machined serrations and shall be activated by one bolt. Housing and grip ring shall be of ductile iron to ASTM A536. Bolt and nut shall be Type 304 Stainless Steel.

## **2.05 COPPER TRACING WIRE**

- A. Use American Wire Gauge (AWG) No. 12-1 solid copper, 600-volt, Type UF or PE cable, UL approved for direct underground burial.
- B. Color: Yellow is preferred. Tracing wire shall be of color different and distinct from that of any active two wire cable, two wire cable jacketing, control wire and/or common wire. Wire color shall be continuous over entire length.
- C. Splices: Use 3M DBR/Y-6 wire connectors with waterproof sealant or approved equal.

## **2.06 MAINLINE COMPONENTS**

- A. POC Assembly: In accordance with all applicable specifications, codes and as presented in drawings and installation details.
- B. Isolation Gate Valve Assembly: as presented in drawings and installation details
- C. Quick Coupling Valve Assembly: as presented in drawings and installation details.
- D. Air Vent Assembly: as presented in drawings and installation details.
- E. Manual Drain Valve Assembly: as presented in drawings and installation details.

## **2.07 IRRIGATION LATERAL COMPONENTS**

- A. Remote Control Valve (RCV) Assembly for Laterals: as presented in drawings and installation details.
- B. Sprinkler Head Assemblies:
  - 1. Spray Heads: As Presented in drawings and installation details. All spray heads shall be a minimum riser height of six-inches (6”).
  - 2. Rotary Spray Heads: As presented in drawings and installation details. All rotary spray heads shall be minimum riser height of six-inches (6”).
  - 3. Rotary Heads: As Presented in drawings and installation details. All rotary heads shall have a riser height of five-inches or greater (5”).

STANDARD CONSTRUCTION SPECIFICATIONS

*Section 02920 - Irrigation*

Page **12** of **31**

- C.     Bubbler Assemblies: As Presented in drawings and installation details.
- D.     Root Watering System (RWS) Assemblies As Presented in drawings and installation details
- E.     Inline Drip Systems or Point-Source Emitter Systems (aka “Bug Emitters”) are not to be used except by approval of Owner and Engineer.

## 2.08

### CONTROL SYSTEM COMPONENTS

- A.     Irrigation Controller Assembly
  - 1.     As presented in drawings and installation details
  - 2.     Lighting protection: Per manufacturer specifications and requirements and as presented in drawings and installation details.
- B.     Power Wire and Components
  - 1.     Use AWG #12, solid or stranded copper, Type UF single-conductor cable or multi-conductor with ground cable, UL approved for direct underground burial from power source to Controller Assembly.
  - 2.     Splices: Use 3M #82-A2 Series with Split Bolts or Butt Connectors for inline splices and 82-B1 or 90-B1 Series for wye splices.
  - 3.     Electrical conduit: Use PVC Schedule 40 conduit conforming to dimensions and tolerances established by ASTM Standard D-1785. Use Schedule 40, Type 1, PVC solvent weld sweep fittings for PVC conduit conforming to ASTM Standards D2466 and D1784 for buried installations. Use rigid metallic conduit with sweep elbows for above grade installations.
  - 4.     Warning tape: Use inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored red, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW."
- C.     Two Wire System From Controller to Decoders and Two Wire Devices (Two Wire, 2-Wire, 2W)
  - 1.     Two Wire Cable (aka Two Wire Path): Use jacketed cable containing two listed Golf Course Sprinkler wires, single conductor, suitable for direct burial and operation up to 600 volts and temperature up to sixty degrees Celsius (60°C).
    - a.     Inner Conductors: Conductors shall be minimum 14 AWG. Conductors shall be soft drawn bare copper meeting ASTM B-3 or B-8. The two conductors shall be twisted with a minimum lay of 4-inches.
    - b.     Overall Jacket: Shall be composed of high-density polyethylene with a thickness of 0.035". Allowable jacket colors are BLUE, PURPLE, TAN, or RED. Use unique colors for distinct two-wire runs and/or as presented in construction drawings and installation details.
  - 2.     Splices: Use only 3M Scotchlok 3750 Connector Sealing Packs (aka Epoxy Packs). 3M DBR-Y connectors or similar products shall not be used on any Two Wire Path splice or Two Wire splice connection to any Two Wire path component or device.

3. Electrical Conduit for Two-Wire Path: Use PVC Schedule 40 conduit conforming to dimensions and tolerances established by ASTM Standard D-1785. Use Schedule 40, Type 1, PVC solvent weld sweep fittings for PVC conduit conforming to ASTM Standards D2466 and D1784 for buried installations. Use rigid metallic conduit with sweep elbows for above grade installations, except as presented in construction drawings, details or as approved by Engineer.
4. Warning tape: Inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored red, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW."
5. Ground two wire cable per manufacturer's guidelines and as presented in installation details and construction drawings.

D. Conventional Wire Path (Low Voltage Control Wire)

1. Control Wire: Use American Wire Gauge (AWG) No. fourteen (#14) solid copper, six hundred (600) volt, Type UF or PE cable, UL approved for direct underground burial from the controller unit to each remote-control valve.
2. Common Wire: Use American Wire Gauge (AWG) No. twelve (#12) solid copper, six hundred (600) volt, Type UF or PE cable, UL approved for direct underground burial from the controller unit to each remote-control valve.
3. Color: Wire color shall be continuous over its entire length
  - a. Control Wire(s): Red. If Project requires multiple controllers whose wire trunks will be installed in a common trench, use different color control wire(s) for each controller. Unacceptable colors are Black, Yellow, Grey, White, Green, Blue.
  - b. Common Wire(s): White. If Project requires multiple controllers, use White wire with a colored stripe matching the Control Wire color of the same controller.
  - c. Spare Control Wire: Green. If Project requires multiple controllers, use Green wire with colored stripe matching Control Wire color of the same Controller.
  - d. Spare Common Wire: Blue. If Project requires multiple controllers, use Blue wire with colored stripe matching Control Wire of the same Controller.
4. Splices: Use 3m DBR/Y-6 connectors with waterproof sealant.
5. Warning tape: Use inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored yellow, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW".

E. Instrumentation:

1. Soil Moisture Sensors: As presented in drawings and installation details.
2. Tipping Rain Bucket: as presented in drawings and installation details.

3. Provide, install, program and test sensors for irrigation controller installed.

## **2.09**

### **OTHER COMPONENTS**

- A. Tools and Spare Parts: As presented in construction drawings, installation details and contract documents.
- B. Other Materials: Provide all other materials or equipment shown on drawings or installation details that are part of the irrigation system, even though items may not have been referenced in these specifications.

## **PART 3 EXECUTION**

### **3.01 INSPECTIONS AND REVIEWS**

- A. Site Inspections:
  - 1. Verify construction site conditions and note irregularities affecting work of this section. Report irregularities in writing to Owner's Representative and Engineer prior to beginning work.
  - 2. Commencement of work implies acceptance of existing site conditions.
- B. Utility Locates ("Call Before You Dig")
  - 1. Arrange and coordinate Utility Locates with local authorities and private utility owners prior to construction.
  - 2. Repair underground utilities that are damaged during construction. Make repairs at no additional cost to Owner.

### **3.02 LAYOUT OF THE WORK**

- A. Stake out irrigation system. Items staked may include sprinklers, directional pipe changes, sleeves, RCV's, ground rods, isolation valves, mainline components and other irrigation features and appurtenances as may be requested by Owner's Representative or Engineer.
- B. Irrigation System Layout Review: Irrigation system layout review will occur after staking has been completed. Notify Owner's Representative one week in advance of review. Modifications will be identified by Owner's Representative at this review.
- C. Install irrigation components inside of project boundaries. Notify Owner's Representative and Engineer immediately of any component that may be installed outside of project boundaries prior to installation.

### **3.03 EXCAVATION, TRENCHING AND BACKFILLING**

- A. Excavate and install pipes at minimum cover indicated in drawings or specifications, whichever is greater or by approval of Engineer. Excavate trenches at appropriate width for connections and fittings.
- B. Trenches receiving PVC Pipe may be curved to change direction or avoid obstructions within limits of the curvature of pipe. Curvature results from bending of pipe lengths. Do not exceed pipe and fitting manufacturer's allowable deflection at joints. Minimum radius of curvature and offset per 20- foot length of pipe by pipe size are shown in following table:

| SIZE | RADIUS | OFFSET PER 20' LENGTH |
|------|--------|-----------------------|
| 1 ½" | 25'    | 3'-4"                 |
| 2"   | 25'    | 3'-4"                 |
| 2 ½" | 100'   | 2'-6"                 |
| 3"   | 100'   | 2'-6"                 |
| 4"   | 100'   | 1'-4"                 |
| 6"   | 150'   | 1'-4"                 |
| 8"   | 200'   | 1'-0"                 |

- C. Minimum Cover (measured from top of pipe, conduit, wire or wire trunk to finish grade)
1. Mainline Pipe:
    - a. Four Inch (4") Nominal Diameter and Smaller: Twenty-four inches (24")
    - b. Six Inch (6") Nominal Diameter and Larger: Thirty inches (30")
  2. Electrical Conduit: Twenty-four (24")
  3. Control Wires (Two Wire Cable, Two Wire Cable Conduit, Low Voltage Common/Control Wire(s): Minimum four inches (4") lower than bottom of mainline pipe and opposite in trench from tracing wire.
  4. Copper Tracing Wire: Minimum four inches (4") lower than bottom of mainline pipe and opposite in trench from control wire(s).
  5. Lateral pipe to sprinklers (6-inch and less pop-up height): 14-inches to top of pipe.
  6. Lateral pipe to sprinklers (12-inch pop-up height): 18-inches to top of pipe.
- D. Install mainline pipe with a continuously positive or negative slope between distinct high and low points. Field verify location of planned high points and Air Relief Valves and report any deviations.
- E. Maintain at least fifteen feet (15') clearance from the centerline of trees.
- F. PVC lateral pipes must be installed in open trench. Pipe pulling is not allowed. Install pipe at burial depths listed above.
1. Generally, lateral lines should not be installed in common trench with other laterals or mainlines except as presented in construction drawings and installation details. When installing in common trench ensure minimum separation of four inches (4") from any pipe wall to any other pipe wall.
- G. Excavated material is generally satisfactory for backfill. See pipe bedding requirements below. Use backfill free from rubbish, vegetable matter, frozen materials, and stones larger than 2-inches in maximum diameter. Remove material not suitable for backfill. Use backfill free of sharp objects next to pipe.



1. Pipe Bedding Requirements: Use backfill material free from rubbish, vegetable matter, frozen materials and stones larger than  $\frac{3}{4}$ " inches. Install bedding material below, around and above pipe to minimum of 4-inches above top of pipe. Install bedding material consistently such that no voids exist between pipe, trench bottom, trench walls or commonly installed laterals, wire paths, wire trunks and/or conduits. Use of flowable fill shall be permitted only on approval of owner and engineer.
- H. After bedding pipe as required and/or approved by Engineer, Backfill buried pipe in either of the following manners:
1. Backfill and puddle lower half of trench. Allow to dry 24 hours. Backfill remainder of trench in 6-inch lifts. Compact each lift to 95 percent of Standard Proctor Density.
  2. Backfill trench by depositing backfill material equally on both sides of pipe in 6-inch lifts and compacting each lift to 95 percent of Standard Proctor Density.
- I. Enclose pipe and wiring beneath roadways and hardscapes in separate sleeves. Neither wire nor wire sleeves may occupy the same sleeve as water carrying pipe or pipe sleeves. Minimum compaction of backfill around sleeves shall be 95 percent of Standard Proctor Density, ASTM D698-78 or as required by construction drawings, details and contract documents. Use of water for compaction around sleeves (aka "puddling") will not be permitted without prior approval by Engineer.
- J. Dress backfilled areas to original grade. Incorporate excess backfill into existing grades.
- K. Contact Owner's Representative for trench depth adjustments where utilities conflict with irrigation trenching and pipe work.

### **3.04**

#### **SLEEVING AND BORING**

- A. Provide sleeving at depth that permits encased pipe or wiring to remain at proper burial depth presented in these specifications unless otherwise specified by construction drawings, details or as approved by Engineer.
- B. Extend sleeve ends twelve to eighteen (12" to 18") inches beyond edge of hardscape as required by these specifications.
- C. Cap sleeve ends and mark with stakes and/or concrete stamps as may be required by these specifications.
- D. Provide rope or pull-string through sleeve and secure to stake at surface grade at each end for future sleeve location.
- E. Bore for sleeves under obstructions that cannot be removed. Employ equipment and methods designed for horizontal boring.

### **3.05**

#### **ASSEMBLING PIPE AND FITTINGS**

- A. General Considerations
  1. Keep pipe free from dirt and debris. Cut pipe end square, deburr and clean as recommended by manufacturer and according to accepted industry practices.
  2. Use only strap-type friction wrenches for threaded plastic, epoxy coated or red prime coated pipe and fittings.

3. Keep ends of assembled pipe capped or plugged. Remove caps or plugs only when necessary to continue assembly.
  - a. Contractor shall be responsible for replacing any damaged components of and/or repairing any other damages to irrigation system caused by any debris of any kind which has entered assembled pipe at no additional cost to Owner.

B. PVC Mainline and Lateral Pipe and Fittings

1. Rubber Gasketed Pipe: Use pipe lubricant approved for use with pipe and fitting manufacturers. Joint pipe in manner recommended by manufacturer and in accordance with accepted industry practices.
2. PVC Solvent Welded Pipe and Fittings:
  - a. Use only purple primer and heavy-set (aka “Gold”) solvent cement. Clear primers and “hot-set” or “quick-set” cements shall not be used. Join pipe in manner recommended by manufacturer and in accordance with accepted industry practices, including:
    - i. Ensure pipe and fitting are free of debris, dirt, dust, water, oils and are generally entirely clean at the pipe joint.
    - ii. Score male pipe with medium sand-paper or emery cloth along a pipe length at least one quarter inch (1/4)” longer than the depth of the female socket receiving the male pipe.
    - iii. Make cuts square to pipe center line.
    - iv. Chamfering of male pipe ends when joining to female socket fittings.
    - v. Ensure male pipe end is inserted fully into female socket.
  - b. Cure for 30 minutes before handling and 24 hours before allowing water in pipe.
  - c. Snake pipe from side to side within trench.
3. PVC Threaded Fittings
  - a. Use only factory-formed threads. Field-cut threads are not permitted.
  - b. Apply thread sealant in manner recommended by component, pipe and sealant manufacturers and in accordance with accepted industry practices.
  - c. Use plastic components with male threads and metal components with female threads where connection is plastic-to-metal.
4. Other considerations:
  - a. Use of cross type fittings is not permitted.
  - b. Use of PVC expansion fittings (aka “Flow-Spans”) or PVC Compression Couplings and Fittings are not permitted.

C. HDPE Mainline Pipe and Fittings

1. Join pipe lengths using butt-fusion technique as recommended by pipe manufacturer.
  2. The following are acceptable methods to join HDPE pipe to dissimilar materials:
    - a. MNPT (316 Stainless) x Butt Fusion
    - b. IPS Spigot x Butt Fusion, with Pipe Stiffener and Joint Restrained Gasketed DI Coupling and necessary restraining harness conforming to these specifications for DI Fittings and joint restraint harnesses.
    - c. Flange x Butt Fusion, with ductile iron backup ring.
- D. Specialized Pipe and Fittings
1. Copper Pipe:
    - a. Use flux and solder. Join pipe in manner recommended by manufacturer and in accordance with local codes and accepted industry practices.
    - b. Solder so that continuous bead shows around the joint circumference.
  2. Ductile Iron Pipe: Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices and as presented in installation details and construction drawings.
  3. Insert dielectric union or flange wherever non-ferrous materials (copper, brass, bronze) and ferrous materials (iron, galvanized steel, stainless steel) are joined.
  4. Low Density Polyethylene Hose: Install hose and compatible fittings in manner recommended by manufacturer and in accordance with accepted industry practices.
  5. Flanged connections: Install fittings, fasteners and gaskets in manner recommended by manufacturer and in accordance with accepted industry practices.
- E. Joint Restraint Harness:
1. Use on pipe greater than or equal to 3-inch diameter or any diameter of rubber gasketed pipe. Use a joint restraint harness wherever joints are not positively restrained by flanged or threaded fittings.
  2. Use a joint restraint harness with transition fittings between metal and PVC pipe or where extra support is required to retain fitting or joint.
  3. Use restrained casing spacers for gasketed pipe routed through sleeving. Install harness in the manner recommended by the manufacturer and in accordance with accepted industry practices. Install self-restraining casing spacers at all gasketed pipe bell joints and every 10-feet along the gasketed mainline pipe installed through sleeving. Provide correct number and type of restraints per manufacturer's requirements.

### **3.06**

## **INSTALLATION OF COPPER TRACING WIRE**

- A. Install tracing wire as shown in the details.
- B. Do not tape tracing wire to pipe. Install tracing wire minimum of four inches (4") away from and below pipe; opposite in trench from any control wire, two wire path or wire trunk.
- C. Bring tracing wire to the surface in all mainline component valve boxes as shown on the details. Provide a thirty-inch (30") loop of wire, coiled about a one-inch PVC Pipe.

### **3.07**

#### **INSTALLATION OF MAINLINE COMPONENTS**

- A. POC Assembly: Provide where indicated on drawings per installation details. All Master Valves or Hydrometers shall be installed above grade with the POC Assembly. Installation of Master Valves or Hydrometers below grade shall not be permitted.
- B. Isolation Gate Valve Assembly: Provide where indicated on drawings per installation details. Install at least 12-inches from and aligned with adjacent walls or edges of paved areas. Brand "GV" on valve box lid two inch (2") high letters.
- C. Quick Coupling Valve Assembly: Provide where indicated on drawings per installation details. Brand "QC" on valve box lid in two inch (2") high letters.
- D. Vent Assembly: Install where indicated on drawings or nearest high point, not closer than 2-feet from nearest fitting. Brand "AV" on valve box lid in two inch (2") high letters.
- E. Manual Drain Valve Assembly: Provide where indicated on drawings per installation details. Brand "DV" on valve box lid in two inch (2") high letters.

### **3.08**

#### **INSTALLATION OF IRRIGATION HEADS AND END-POINT DELIVERY COMPONENTS**

- A. Remote Control Valve (RCV): Provide where indicated on drawings per installation details.
  - 1. Provide thirty inches (30") of control wire/cable on both the incoming and outgoing wire paths at each RCV. These lengths may be coiled together or separately.
  - 2. Flush mainline before installation of RCV assembly.
  - 3. Provide where indicated on drawings. Use wire connectors as specified for the wiring type to connect control wire to RCV solenoid wires.
  - 4. Provide only one RCV to a valve box. Co-locating multiple RCV's in one valve box shall not be permitted. Locate valve box at least twelve inches (12") from and aligned with nearby walls or edge of paved areas. Group RCV assemblies together where practical. Align grouped valve boxes in uniform patterns. Allow at least twelve inches (12") between valve boxes. Brand station number on valve box lid in two inch (2") high letters. Brand controller number, where applicable to sites with multiple controllers, in two inch (2") high letters. Branding device must create letters a minimum of two inches (2") in height and an impression into lid of no less than 0.2 inches.

5. Tee and elbow fittings shall not be located inside valve box. Tee and elbow fittings shall be outside of the box. No part of the box shall be in contact with mainline or lateral pipe or fittings.
6. Valve box shall be supported in all corners of the box with bricks to minimize settling of the box.
7. Bring wire carrying conduit into box such that it does not interfere with the operation of any valve stem, union, solenoid or other irrigation component or appurtenance.
8. Locate valve within box such that the box walls and lid do not interfere with the operation of any valve stem, union, solenoid or other irrigation component or appurtenance.
9. Attach ID tag with controller number to control wiring. Brand ID tag with RCV number and controller identifier, where applicable to sites with multiple controllers.
10. Install RCV assemblies such that valve stem and isolation valves are plumb, can be operated freely and are not obstructed by any other component or appurtenance.

B. Rotary, Rotary Spray and Spray Head Assemblies

1. Flush lateral pipe before installing sprinkler assembly.
2. Provide per installation details at locations shown or directed on drawings.
3. Locate rotary and rotary spray heads 6-inches from adjacent walls, fences, or edges of paved areas.
4. Locate spray heads 3-inches from adjacent walls, fences, or edges of paved areas.
5. Install sprinklers perpendicular to finish grade or as indicated on construction drawings, details or as approved by Engineer or Owner's Representative.
6. Provide appropriate nozzle or adjust arc of coverage of each sprinkler for best performance and uniform coverage.
7. Adjust radius of throw of each sprinkler for best performance and uniform coverage.

C. Bubbler Assemblies

1. Flush lateral pipe before installing bubbler assembly.
2. Provide bubbler assembly per installation details at locations shown or directed on drawings.

- D. Root Watering System (RWS) Assemblies
  - 1. Flush lateral pipe before installing RWS assemblies.
  - 2. Provide RWS assembly per installation details at location shown or directed on drawings.

### **3.09**

## **INSTALLATION OF CONTROL SYSTEM COMPONENTS**

- A. Irrigation Controller Assembly:
  - 1. Location of Controller Assembly as depicted on drawings is approximate. Owner's Representative will approve exact site location during Irrigation System Layout Review. Install controller assembly and enclosure in accordance with controller manufacturer recommendations and as presented in installation details and construction drawings.
  - 2. Lightning Protection: As recommended and required by manufacturer and presented in installation details and construction drawings.
  - 3. Coordinate installation of electrical service in accordance with local electric codes. Contractor is responsible for obtaining all permits, permit fees, meter fees and other costs incidental to the completion of the work.
- B. Power Wire:
  - 1. Install with minimum number of field splices. If power wire must be spliced, make splice with recommended connector, installed per manufacturer's recommendations. Locate splices in standard rectangular valve box. Coil 3-feet of wire in valve box.
  - 2. Install power wire using open trenches. Use of a vibratory plow is not permitted.
  - 3. Use green wire as common ground wire from power source to controller assembly.
  - 4. Carefully backfill around power wire to avoid damage to wire insulation or wire connectors.
  - 5. Install wire in conduit parallel with mainline pipe unless noted otherwise on plans. Install wire offset from bottom of mainline pipe or at depth required by local codes, whichever is deeper. Ensure edge of conduit is a minimum of 4-inches away from edge of any other conduit, mainline pipe, lateral pipe, wire path and/or wire trunk.
  - 6. Encase wire in electrical conduit with a continuous run of warning tape placed in the backfill, 6- inches above the conduit.
  - 7. When bringing power wire into irrigation controller, ensure power wire is isolated from low voltage wire. Power and low-voltage wire shall not occupy the same space. Isolation may be accomplished by running power wire in conduit inside the controller enclosure.
- C. Two Wire System From Controller to Decoders and Two Wire Devices (Two Wire, 2-Wire, 2W)

1. Install cable in minimum one-inch (1") PVC Sch 40 conduit parallel with, and not less than four inches (4") lower than and offset from mainline pipe unless noted otherwise on plans. Install cable in conduit on opposite side of trench from tracer wire.
2. All two-wire cable shall be installed within one-inch (1") or larger conduit. Conduit shall be water tight and shall only contain the two-wire cable. No other wire, pipe or conduit may occupy the same conduit as the two-wire cable. Use long radius sweep elbows. Heat bending is not allowed. Conduit ends shall be sealed with a duct sealant.
3. Provide thirty inches (30") of wire/cable on both the incoming and outgoing wire paths at each control valve box, master valve and any other electrically controlled in-ground component. These lengths may be coiled together or separately.
4. Install Two-Wire with the minimum possible number of field splices. If cable must be spliced, make splice with only 3M Scotchlok 3570 Connector Sealing Packs (aka "Epoxy Packs"), installed per manufacturer's recommendations. Locate splices in housing afforded by other control system components or separate ten-inch (10") round valve box. Coil thirty inches (30") of wire/cable on both the incoming and outgoing wire paths in each box containing a splice.
5. 3M Scotchlok 3570 Connector Sealing Packs shall only be installed:
  - a. At temperatures at or above 55 degrees Fahrenheit (55°F)
  - b. If the ambient air temperature will be maintained at or above 55 degrees Fahrenheit (55°F) for a twenty-four (24) hour period after installation.
6. Direct Bury Two-Wire shall only be used as indicated on the drawings or by approval of Owner's Representative and Engineer. Unless otherwise noted, protect cable not installed with PVC mainline pipe with a continuous run of warning tape placed in the backfill twelve inches (12") above the wiring.
7. Lightning protection: Install grounding equipment per manufacturer's guidelines and as presented in installation details and construction drawings.
8. When stripping control wire, only expose minimum necessary length of copper to connect into terminal or construct proper wire splice. Bare copper left exposed outside of a terminal or splice shall not be accepted.
9. Terminate two-wire dead ends per manufacturer requirements and recommendations.

D. Low Voltage Control Wire (Conventional Wire)

1. Bundle control wires where two or more are in the same trench. Bundle with pipe wrapping tape spaced at ten foot (10') intervals.
2. Provide thirty inches (30") of wire/cable on both the incoming and outgoing wire paths in each control valve box, master valve and any other electrically controlled in-ground component. These lengths may be coiled together or separately.

3. Install common ground wire and one (1) control wire for each remote-control valve. Multiple valves on a single control wire are not permitted.
4. Spare Control Wires:
  - a. Non-Looped Mainlines or Mainline Sections: Provide minimum of two (2) continuous spare control wires from controller to the last RCV on any given mainline section(s). Separate sections may share spare control wires.
  - b. Looped Mainlines: Provide a minimum of two (2) continuous spare control wires from controller. Route spare control wires such that they will intercept each and every RCV's on looped mainline sections. Dead end terminate spare wire(s) at last RCV in sequence. Do not loop-connect spare control wires. Separate mainline loops shall have separate spare control wires.
  - c. Terminate all spare wires in separate water-proof connectors per these specifications for conventional wire splices.
5. Spare Common Wires:
  - a. Non-Looped Mainlines or Mainline Sections: Provide minimum of one (1) continuous spare common wire from controller to the last RCV on any given mainline section(s). Separate sections may share a spare common wire.
  - b. Looped Mainlines: Provide a minimum of one (1) continuous spare common wire from controller. Route spare common wire such that it will intercept each and every RCV on any given looped mainline sections. Dead ends terminate spare wire(s) at last RCV in sequence. Do not loop-connect spare control wires. Separate mainline loops shall have separate spare common wires.
  - c. Terminate all spare wires in separate water-proof connectors per these specifications for conventional wire splices.
6. No control wires shall be spliced under 2000 LF of wire without approval of Owners Representative or Engineer. If a control wire must be spliced, make splice with wire connectors and waterproof sealant per these specifications or as indicated in the Contract Documents, installed per the manufacturer's instructions. Locate splice in a valve box that contains an irrigation mainline component, RCV assembly, or in a separate ten inch (10") standard round valve box. Use same procedure for connection to valves as for in-line splices. Brand this valve box with an (SPL) for splice.
7. Install wire parallel with and offset from mainline pipe unless noted otherwise on plans. All wire(s) shall be a minimum of four inches (4") below and away from bottom of mainline pipe. Wire must be offset from mainline pipe and installed in trench opposite from Copper Tracer Wire. Wires installed shall not be in contact with mainline pipe at any point.



8. Unless otherwise noted, protect wire not installed with PVC mainline pipe with a continuous run of warning tape placed in the backfill twelve inches (12") above the wiring.
  9. When stripping control wire, only expose minimum necessary length of copper to connect into terminal or construct proper wire splice. Bare copper left exposed outside of a terminal or splice shall not be accepted.
- E. Instrumentation
1. Provide, install, and program sensors and instruments as indicated on drawings and installation details, and in accordance with manufacturer's recommendations.

### **3.10 INSTALLATION OF OTHER COMPONENTS**

- A. Tools and Spare Parts: Prior to Review at completion of construction, supply to Owner such additional equipment, tools, spare parts and other items as may be indicated on the construction drawings, details and contract documents.
- B. Other Materials: Provide other materials or equipment shown on drawings or installation details that are part of the irrigation system, even though items may not have been referenced in specifications.

### **3.11 PROJECT RECORD (AS-BUILT) DRAWINGS**

- A. The Contractor is responsible for documenting changes to the design. Maintain on-site and separate from documents used for construction, one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded.
- B. Record pipe and wiring network alterations. Record work that is installed differently than shown on the construction drawings. Record accurate reference dimensions, measured from at least two permanent reference points of each irrigation system valve, each backflow prevention device, each controller or control unit, each sleeve end, each stub-out for future pipe or wiring connections, and other irrigation components enclosed within a valve box.
- C. Turn over the "Record Drawings" to the Project Manager. Completion of the Record Drawings will be a prerequisite for the Review at the completion of the irrigation system installation.

### **3.12 WINTERIZATION AND SPRING START-UP**

- A. Unless specifically provided for otherwise in the contract documents, Contractor shall be responsible for one (1) full Winterization of all irrigation components and one (1) full Spring Start-Up of all irrigation components following final completion and acceptance of the irrigation system. All necessary winterization and start-up prior to final completion shall be the Contractor's responsibility.
- B. Winterize the irrigation system in the fall after the installation and acceptance of the irrigation system. Start-up the irrigation system the following spring. Repair any damage caused in improper winterization at no additional cost to the Owner. Coordinate the winterization and start-up with the Owner's Representative and Engineer.

STANDARD CONSTRUCTION SPECIFICATIONS

*Section 02920 - Irrigation*

Page **26** of **31**

- C. All winterizations shall be witnessed by the Owner's Representative. A representative of the Parks Department shall also be notified a minimum of (1) day prior to the winterization in case they would elect to witness this process.
- D. If the winterization affects a separate irrigation system, Owner's Representatives will be on site to assist with this process. Contractor is responsible for coordinating with the Owner.
- E. Perform Spring-Start up in manner substantially identical to System Operational Test (See Part 1.05.I).
- F. Unless specifically provided for otherwise in the contract documents, all labor, equipment, and materials related to the Winterization and Spring Start-Up of the irrigation system shall be considered incidental to the completion of the work. No separate payment shall be made regarding the Contractor's performance and completion of Winterization or Spring Start-Up as described in these specifications.

### **3.13 MAINTENANCE**

- A. Upon completion of construction and Review by the Owners Representative and/or Engineer, maintain irrigation system for a duration of thirty (30) calendar days. Make periodic examinations and adjustments to irrigation system components so as to achieve the most desirable application of water.
- B. Following completion of the Contractor's maintenance period, the Owner will be responsible for maintaining the system in working order during the remainder of the guarantee/warranty period, for performing necessary minor maintenance, for trimming around sprinklers, for protecting against vandalism, and for preventing or avoiding damage during Owner's landscape maintenance operations.

### **3.14 CLEANUP**

- A. Remove any machinery, tools, excess materials, and rubbish from the site upon completion of the work.

### **END OF SECTION**

## SECTION 323113 - CHAIN LINK FENCE AND GATES

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SCOPE OF WORK

- A. The work required under this Section consists of furnishing and installing the following:
  - 1. Galvanized chain-link fabric line fencing (non-welded framework);
  - 2. Galvanized chain-link fabric single and double leaf swing gates;
  - 3. Exit hardware and self closing gate hinge;

#### 1.3 SUBMITTALS

- A. Shop Drawings: Include complete details of fence and gate construction, fence height, post spacing, dimensions and unit weights of framework and concrete footing details, only if the installers installation details/procedures differ from those indicated on the drawings or within this specification.
- B. Product Data: For each type of product / gate hardware type.

#### 1.4 QUALITY ASSURANCE

- A. Reference Standards: Standards referenced hereunder and referenced in these specifications shall become a part of this specification and are incorporated herein by reference. The latest edition, amendment, or supplement thereto in effect thirty-days (30) before the date of construction shall apply.
  - 1. American Society for Testing Materials (ASTM):
    - a. ASTM F-1043 – Group 1C Galvanized Fence Posts and Rails
    - b. ASTM A123 - Zinc (hot galvanized) Coatings on Steel Products
    - c. ASTM A153 - Zinc Coating (hot-dipped) on Iron and Steel Hardware
    - d. ASTM A392 - Class I – Woven Chain Link Fabric, Hot-Dipped Zinc

#### 1.5 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One (1) year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 CHAIN-LINK FENCE FABRIC

- A. Fabric: The chain link fabric shall be woven into diamond shape mesh in which the individual pickets are helically woven and interwoven in the form of a continuous chain link mesh.
  - 1. Fabric shall be knuckled at both selvages.
  - 2. Fabric gauge shall be 9 ga. unless indicated otherwise on the drawings.
  - 3. Fabric heights as indicated on the drawings.
  - 4. Fabric mesh size as indicated on the drawings.
- B. Galvanizing: Galvanizing-After-Weaving chain link fabric shall be gauge specified before hot-dip and woven of good commercial steel wire with a uniform diamond mesh in sizes specified +/- 1/8" between its parallel sided, galvanized after weaving by the hot-dip process to give a minimum of 1.2 ounces of zinc per square foot of wire surface distributed over the entire fabric, including cut ends as per ASTM A 392, Class I.

### 2.2 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 per ASTM F-1043 based on the following:
  - 1. Fence Height(s): As indicated on Drawings.
  - 2. Horizontal Framework Members: Intermediate, top and bottom rails per ASTM F-1043 and as indicated on the Drawings.
  - 3. Brace Rails: ASTM F 1043
  - 4. Metallic Coating for Steel Framework:
    - a. Type A zinc coating.
- B. Connections. Fittings shall be allowed at rail to post connections.

### 2.3 SINGLE & DOUBLE LEAF SWING GATE HARDWARE

- A. General: ASTM F-900 for gate posts and single and double swing gate types.
  - 1. Gate Leaf Width: Varies, as indicated on the Drawings.
- B. Pipe and Tubing:
  - 1. Zinc-Coated Steel: ASTM F-1043; to match fence framework.
  - 2. Gate Posts: See 2.2, B. 1. Above.
  - 3. Gate Frames and Bracing: 1-1/2" nominal (1.9" O.D.) galvanized pipe
- C. Gate Frame Corner Construction: Gate fitting corners or welded- Contractor's option.
- D. Latches: Integral padlock eye, operable from either side.
  - 1. Malleable "fork type" for single . 4'w. gates, unless called out as requiring exit Hardware. See detailing.
  - 2. Fulcrum / Pioneer latch for double gates and single gates 6'w. and wider.

## 2.4 EXIT HARDWARE and SELF-CLOSING DEVICES

### A. Exit Hardware:

1. Basis of Design:
  - a. Detex Corporation  
[www.detex.com](http://www.detex.com)  
ph: 800.729.3839
2. Model: V40 Series rim exit device – #6045 ‘Superior Exit Bar Kit’ – 48” Bar w/ Silver Plate (#6045-S48)
  - a. Surfaced mounted weather resistant exit bar #6003 or #6004
  - b. 12” tall Mounting Plate
  - c. Lock Box with keyed cylinder
  - d. Adjustable receiver bracket with strike
  - e. Stainless steel screws, fasteners.
  - f. Model #6100 Outside Trim Kit (for 6045 Kit)
    - 1) Lever Style Handle
    - 2) Mortise Cylinder w/ keys
    - 3) Aluminum Finish

### B. Self-Closing Device – required for all gates with panic hardware only.

1. Locinox – Heavy Duty 180 degree hydraulic gate closure and hinge, weather proof aluminum housing, ADA compliant
  - a. Item # MAMMOTH180-
  - b. Color: ZILV
  - c. Provide fittings / adapters as required to facilitate self-closing hinge attachment to round gate posts.

## 2.5 FITTINGS, HARDWARE, ACCESSORIES

### A. Fittings: Where allowed, fittings, caps and other appurtenances shall be aluminum alloy galvanized pressed steel, malleable or cast steel. Painted fittings are not allowed.

### B. Connectors:

1. The chain link fabric shall be securely fastened to terminal posts using ¼” x ¾” tensions bars with 14 gauge x 1” steel pressed steel bands spaced no more than sixteen-inches (16”) apart. These bands shall be equipped with 3/8” diameter carriage bolts and nuts. Bolt heads shall be in the field / court side of all fencing.
2. The Fabric shall be fastened to the Line Posts with 12 gauge steel ties spaced approximately sixteen-inches (16”) apart, and to the Top Rail with 12 gauge steel ties on approximately twenty-four inch (24”) centers.
3. Posts Tops: Rounded, dome style, weather-tight closures. Same material and diameter as the Posts.

### C. Sleeves: 6” long, galvanized steel.

## 2.6 GROUT AND ANCHORING CEMENT (if required)

- 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 GENERAL

- A. The chain link fence, gates and accessories shall be installed in strict accordance with plans and specifications in a workmanlike manner and conforming to ASTM F -567. Provide all material and hardware to complete job as per manufactures recommendations, including clamps, post caps, etc. Posts to be true and plumb.

### 3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of five-hundred feet (500') 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 per ASTM F 567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing's 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. Exposed Concrete: None.
    - b. Concealed Concrete: Place top of concrete two-inches (2") below grade to allow covering with surface material.

- D. Terminal and Gate Posts: Install terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at ten-feet (10') o.c. unless otherwise indicated on the Drawings.
- F. Rail(s):
  - 1. Set rail(s) parallel to the finish grade and at the specified height of the fence. If detailed/specified, mid-rail to be installed at mid-height of the fence and bottom rail to be installed 2" above finished surface.
- G. Chain-Link Fabric:
  - 1. Apply fabric to the Outside of the framework (facing away from school buildings).
  - 2. Leave 2-inch maximum bottom clearance between finish grade (concrete mow band, concrete flat work) and bottom selvage unless otherwise indicated.
  - 3. Pull fabric taut and tie to posts, rails, and tension wires.
  - 4. Anchor to framework so fabric remains under tension after pulling force is released.

### 3.4 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

## SECTION 32 31 19 - DECORATIVE METAL FENCES AND GATES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Decorative steel fences.
  - 2. Swing gates.
  - 3. Gate hardware

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For gates and fencing. Include plans, elevations, sections, details, grounding, hardware, and attachments to other work.
- C. Samples: For each fence material and for each color specified.

#### 1.3 QUALITY ASSURANCE

- A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

#### 1.4 REFERENCES

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- C. ASTM D523 - Test Method for Specular Gloss
- D. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- E. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
- F. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- G. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- H. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- I. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
- J. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

#### 1.5 PRODUCT HANDLING AND STORAGE

- A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

#### 1.6 PRODUCT WARRANTY

- A. Structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover defects in material finish, including cracking, peeling, chipping, blistering or corroding.



- B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase

## PART 2 - PRODUCTS

### 1.7 MANUFACTURER

- A. The fence system shall be manufactured by Ameristar Fence Products, Inc., in Tulsa, Oklahoma, OR pre-approved equivalent.
  - 1. Style: Montage Plus
  - 2. Fence Height: per the drawings
  - 3. Welded and Rackable
  - 4. Ornamental Steel
  - 5. Majestic with 3" air space
  - 6. Flush bottom rail treatment
  - 7. 3-Rail style
  - 8. Finish: Black

### 1.8 MATERIAL

- A. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 oz/ft<sup>2</sup> (184 g/m<sup>2</sup>), Coating Designation G-60.
- B. Material for pickets shall be 3/4" square x 18 Ga. tubing. The rails shall be steel channel, 1.5" x 1.4375" x 14 Ga. Picket holes in the rail shall be spaced for 3" air space. Fence posts and gate posts shall meet the minimum size required by manufacturer for site and soils conditions.

### 1.9 FABRICATION

- A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.
- B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by shop welding process, thus completing the rigid panel assembly.
- C. The manufactured panels and posts shall be subjected to an inline electrode position coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2.
- D. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Commercial weight fences under ASTM F2408.

### 1.10 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

### 1.11 GROUNDING MATERIALS

- A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
  - 1. Material above Finished Grade: Aluminum.
  - 2. Material on or below Finished Grade: Copper.
- B. Grounding Connectors and Grounding Rods: Comply with UL 467.

## PART 2 - EXECUTION

### 2.1 DECORATIVE FENCE INSTALLATION

- A. Fence shall be laid out by the contractor in accordance with the construction plans.
- B. Fence post shall be spaced according to manufacturer's instructions, plus or minus ¼". For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer. Posts shall be set in concrete footers having a minimum depth of 36". The "Earthwork" and "Concrete" sections of this specification shall govern material requirements for the concrete footer.

### 2.2 FENCE INSTALLATION MAINTENANCE

- A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces; 1) Remove Metal shavings from cut area. 2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Manufacturer's spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of parts or components that are not supplied by the fence manufacture will negate the manufactures' warranty.

### 2.3 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
  - 1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 200 feet.
  - 2. Gates and Other Fence Openings: Ground fence on each side of opening. Bond metal gates to gate posts.
- B. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- C. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
- E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

### 2.4 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.
  - 1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than

natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.

2.5 CLEANING

- A. The contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.
- B. Fences shall be cleaned removing dirt, debris and other foreign materials.

END OF SECTION

## SECTION 323400 - TRAFFIC SIGNS

### PART 1 - GENERAL

#### 1.01 SUMMARY:

- A. This Work shall consist of the installation of new traffic control signs.

#### 1.02 RELATED REQUIREMENTS

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 033100 - Site Concrete Work
- C. Section 321216 - Asphalt Paving
- D. Section 321313 - Concrete Paving

#### 1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- C. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- G. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
- H. ASTM D4956 - Standard Specification for Retroreflective Sheeting for Traffic Control.
- I. FHWA MUTCD - Manual on Uniform Traffic Control Devices.

### PART 2 - PRODUCTS

#### 2.01 SIGN PANELS:

- A. Sheet Aluminum: Aluminum sheet shall be 5052-H38 or 6061-T6 alloy conforming to the requirements of ASTM B209/B209M. The metal shall not be in contact with grease, oil, or other contaminants after being cleaned and etched and prior to the application of reflective sheeting.
  - 1. The treatment of the aluminum surface shall be done by a chemical conversion method. The panels may be anodized or chemically treated by an approved process. Any chemical immersion baths shall be of adequate capacity and shall be maintained within correct limits of operating strength by reliable control methods.

- B. Aluminum Alloy Channels and Tubing: Aluminum alloy channels and tubing shall conform to the requirements of ASTM B221 for alloy 6061-T6.
- C. Reflective Sheeting (High Intensity): The reflective background on sign panels shall be wide-angle, flat-top reflective sheeting, and colors shall be as shown in the Plans. Reflective sheeting shall consist of glass spheres embedded between a smooth, flexible, transparent plastic and suitable non-cellulosic backing material. The reflective sheeting shall meet the following requirements:

| <p style="text-align: center;">:</p> <b>MINIMUM BRIGHTNESS VALUES</b><br><b>AT -4° AND 40° DIVERGENCE</b><br>Unit-average Candle Power per Foot-Candle per Sq. Ft. |              |           |           |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|-----------|-----------|
| Div. Angle                                                                                                                                                         | Silver White | Yellow    | Red       | Brown     |
|                                                                                                                                                                    | 0.2° 0.5°    | 0.2° 0.5° | 0.2° 0.5° | 0.2° 0.5° |
| Inc. Ang.                                                                                                                                                          |              |           |           |           |
| -4°                                                                                                                                                                | 70.0 30.0    | 50.0 25.0 | 14.5 7.5  | 2.0 1.0   |
| 30°                                                                                                                                                                | 30.0 15.0    | 22.0 13.0 | 6.0 3.0   | 1.0 0.5   |
| Div. Ang                                                                                                                                                           |              | Blue      | Green     | Orange    |
|                                                                                                                                                                    |              | 0.2° 0.5° | 0.2° 0.5° | 0.2° 0.5° |
| Inc. Ang.                                                                                                                                                          |              |           |           |           |
| -4°                                                                                                                                                                |              | 4.0 2.0   | 9.0 4.5   | 25.0 13.5 |
| 30°                                                                                                                                                                |              | 1.7 0.8   | 3.5 2.2   | 7.0 4.0   |

- The color and allowable tolerance of the reflective sheeting shall conform to the specifications as detailed on the "Color Tolerance Charts for Standard Highway Sign Colors." Order Stock No. PB-169 553 and No. PB-202000 COLOR TOLERANCE CHARTS from National Technical Information Service, Port Royal Road, Springfield, Virginia 22151 and meeting the sign color requirements of the current edition of the FHWA MUTCD. Inspections to ensure that reflective sheeting meets the above requirements may be made by the Architect/Engineer. For sheeting colors not referred to herein, see manufacturers recommended color specifications.
- The brightness of the sheeting when totally wet shall be not less than 90 percent of the above values. Wet performance measurements shall be conducted in conformance with standard rainfall test specified in ASTM D4956.
- The sheeting shall be pre-coated with an adhesive which will, after application, be elastic enough to resist shocking off when struck at a temperature of -10°F. When subjected to the peeling test as outlined in ASTM D903, the adhesive shall resist peeling with a force of five pounds per inch in width. The adhesive shall have no staining effect on the reflective sheeting and shall be mildew resistant.
- Reflective sheeting used for all background material on signs shall be applied in conformance with the manufacturer's requirements. Sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified for the manufacturer of traffic control signs by the sheeting manufacturer. Type II adhesive coated sheeting shall be pre-perforated.
- Sign faces comprising two or more panels of reflective sheeting shall be carefully matched for color to provide uniform appearance and brilliance, day and night.
- Alternate successive width sections of either sheeting or panels shall be reversed to ensure that corresponding edges of reflective sheeting lie adjacent on the finished sign. Non-uniform shielding and as undesirable contract between adjacent widths of applied sheeting will not be acceptable.

7. Type II adhesive coated sheeting may be spliced with overlap not less than 3/16 inch or butted with the gap not to exceed 1/32 inch. Only butt splices shall be permitted on signs screen processed with transparent color. Sheeting applied to extruded sections, or plywood panels, shall extend over the top edges and down the side legs a minimum of 1/16 inch.
8. Reflective sheeting splices and sign edges shall be sealed with material supplied and specified by the sheeting manufacturer.

## 2.02 SIGN SUPPORTS:

- A. Steel pipe sign posts shall conform to the requirements of ASTM A53/A53M for Schedule 40, Grade B. Steel plates and shapes shall conform to the requirements of ASTM A36/A36M. Unless otherwise specified, posts and all steel parts shall be galvanized.
- B. Tubular steel sign posts shall be roll-formed from galvanized, cold-rolled sheet steel, and shall meet the requirements of ASTM A653/A653M for Grade A. The cold-rolled steel, including all connecting hardware, will be hot-dipped galvanized in accordance with ASTM A653/A653M, Des. G-90. Corner welds shall be zinc-coated following the scarfing operation. Post sizes and gauges shall be shown in the Plans.

## 2.03 BOLTS AND FASTENERS

- A. These materials shall meet the requirements of ASTM A307, Grade A. Sign panel elevator bolts and sign bolts shall be galvanized.

# PART 3 - EXECUTION

## 3.01 CONSTRUCTION METHODS:

- A. Traffic control signs. The Architect/Engineer's decision to relocate or install new street or traffic control signs shall be based on the location of the sign with respect to curb line, sidewalk line and the staked grading limits.
- B. Signs within the staked grading limits whose existing location does not conform to final plan location tolerance will be relocated. Signs within the staked grading limits whose existing location (both vertically and horizontally) conform to final plan location within a six-inch tolerance will not be relocated. Signs outside the staked grading limit shall also be relocated to conform to final plan location.
- C. The preservation of the signs that are to remain in place shall be the responsibility of the Contractor while the job is under construction. Should any of the signs need to be moved for the Contractor's convenience, they shall be removed by the Contractor, either temporarily reinstalled or stored, and permanently reinstalled when construction is completed. The Contractor shall be held liable for any damage to these signs caused by neglect on his part and no extra compensation will be allowed for preserving, removing or replacing stop and other traffic control and direction signs designated to remain in place, but rather this work shall be considered as included in the contract unit prices for the various items of the contract.
- D. Signs designated to be relocated shall be removed and reinstalled in the locations shown in the Plans, or as designated by the Architect/Engineer.
- E. Signs designated as new shall be installed with new materials conforming to these Specifications at locations designated by the Architect/Engineer, or shown in the Plans.
- F. The following procedures will be followed in removing and relocating both signs removed by the Contractor for his convenience, and signs designated by the Architect/Engineer for relocation:

1. After it has been determined which signs shall be relocated, the Contractor will notify the Architect/Engineer as to which signs are to be removed and reinstalled.
  2. Upon receiving the Contractor's notification, a representative of the Owner or Architect/Engineer will inspect the signs with the Contractor to determine the condition of the signs. Signs which require repair will be delivered by the Contractor to the Owner. Signs not requiring repair will be removed and reinstalled as specified below.
  3. Where stop signs and traffic direction or control signs are removed, the Contractor shall provide temporary traffic control in compliance with the Architect/Engineer approved traffic control plan.
  4. Signs may be installed temporarily upon approval by the Architect/Engineer.
  5. Signs not required or used for temporary installation shall be stored.
  6. All signs shall be reinstalled in the permanent location shown in the Plans, or designated by the Architect/Engineer as soon as possible after the construction is completed. Signs which have been damaged after removal shall be replaced with new signs at the Contractor's expense.
- G. All sign locations and provisions for breakaway shall conform to the latest issue of the Manual on Uniform Traffic Control Devices for Streets and Highways (FHWA MUTCD) published by the U.S. Department of Transportation.
- H. Contractor shall install sign support anchors at the locations specified or as directed by the Architect/Engineer. All work and concrete materials shall conform to the Plans.

END OF SECTION 323400

## SECTION 323900 - MANUFACTURED SITE SPECIALTIES

### PART 1 GENERAL

#### 1.01 Section Includes

- A. Manufactured bollards.
- B. Bollard covers.

#### 1.02 Related Requirements

- A. Section 033000 - Cast-in-Place Concrete.

#### 1.03 Reference Standards

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

#### 1.04 Submittals

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's specifications and descriptive literature including installation instructions, maintenance information, and color charts.
- C. Manufacturer's qualification statement.

#### 1.05 Quality Assurance

- A. Performance: Bollard shall remove completely from the base unit. The bollard body shall be no more than 8 inches below grade to allow for minimal lifting efforts (excludes ASTM and DOS units).
- B. Manufacturer: Bollard units of all types must be supplied by a single manufacturer having the resources to provide consistent quality in appearance and physical properties.
- C. Materials: Steel shall be US domestic mill certified steel. The main body of the product must be constructed from ASTM A500 steel and be accompanied with steel mill certifications/test reports for the steel being used to ensure the durability and performance of the product. Secondary and non-ASTM steel may not be substituted.

#### 1.06 Delivery, storage, and Handling

- A. Package units appropriately to protect finish. Inspect materials to ensure that specified materials have been received.
- B. Store units to avoid damage from moisture, abrasion, and other construction activities.

#### 1.07 Warranty

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.



## PART 2 PRODUCTS

### 2.01 Manufacturers

#### A. Manufactured Metal Bollards:

1. Blue Ember Technologies, LLC. MaxiForce Bollards line of products, Sykesville, MD 21784, Tel 410-552-9888, Fax 410-552-9939, Website: <http://www.maxiforcebollards.com>.
2. Substitutions: See Section 016000 - Product Requirements.

### 2.02 Removable Bollards

#### A. Removable Bollards: Provide MaxiForce Removable Bollards by Blue Ember Technologies or Architect/Engineer approved equivalent product.

1. Body Style: MRRP Round Style, Padlock Operated
2. Head Style: Removable and interchangeable RS1 - Round Style 1 Head for Round or HD Body Style
3. Base Type: As required for Installation R- Removable
4. Padlock Operated Unit (without wrench operation): ): Unlock and remove the padlock to allow the bollard to be removed. Reverse the sequence to return bollard to its original and locked position. Bollard may be returned to its original locked position without the use of any tools or other devices. Coordinate Padlock Installation with Owner & City.
5. Materials: Free from surface blemishes and defects where exposed to view in the finished installation.
  - a. Steel Plate: A36; ASTM A36/A36M
  - b. Steel Tube: A500; ASTM A500/A500M
  - c. Stainless Components: Series 300 Stainless Steel
  - d. Fasteners: Series 300 Stainless Steel
6. Finish: Factory applied after surface imperfections removed and exposed faces of welded joints dressed smooth.
  - a. Powder Coat Finish (Standard): Factory applied TIGER Drylac Powder Coatings Essentials Chart color or equivalent.
  - b. Finish Color - Safety Yellow
  - c. Base (Ground Sleeve) Units: Powder coated with a black textured powder coating to help reduce slippery surfaces when the bollard units are removed.

## PART 3 EXECUTION

### 3.01 Examination

- A. Verify installation of mounting surfaces, preinstalled anchor bolts, and other mounting devices meets manufacturer's requirements for receiving site specialty items.
- B. Do not begin installation until conditions meet manufacturer's requirements.

### 3.02 Installation

#### A. Removable Bollards

1. Comply with manufacturer's recommendations for installation and approved submittals and the following:
  - a. Install bollards level and true and in proper relation to adjacent surfaces.
  - b. Install base units with top plate flush with the finished surface to avoid tripping hazard.

- c. Insert bollard into base unit after the base is leveled and cured.
  - d. Test for proper operation and adjust if necessary.
- 2. Protect bollards from damage during construction operations.

3.03 Field Quality Control

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Inspect for installation in accordance with manufacturer's instructions.

END OF SECTION 323900

## SECTION 329113 - SOIL PREPARATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Soil Types 'A' – Existing Onsite / Stockpiled Soil.
2. Soil Type 'B' – Imported Topsoil (only required if existing soil quantity does not meet the needed).
3. Soil Amendments for Bluegrass Sodded and planting bed areas only. Not required for native seeded areas.

B. Related Requirements:

1. Division 31 "Site Clearing" for topsoil stripping and stockpiling.
2. Division 32 "Earthwork" for grading, excavation, sub-grade, soil stabilization and treatment, slope protection and surface contouring.
3. Division 32 "Turf and Grasses".
4. Division 32 "Plants".

#### 1.2 RELATED DOCUMENTS

A. General Soil Preparation Requirements:

1. It is anticipated that the quantity of the existing stripped and stockpiled topsoil is adequate and no additional topsoil import to the site is necessary.
  - a. If it is deemed that the existing topsoil is of poor quality, does not exist or if the sufficient quantity is not attainable, the Contractor shall provide an imported, approved topsoil product to meet the minimum topsoil specification specified within this Section.

#### 1.3 DEFINITIONS

- A. Imported Soil: Soil that is transported to Project site for use.
- B. Planting Soil: Existing, on-site soil, imported soil, or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- C. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- D. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than one-percent (1%) organic matter and few soil organisms.
- E. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- F. USCC: U.S. Composting Council.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product specified herein:
  - 1. Imported Topsoil (only if needed). It is anticipated that existing topsoil material is available on this site.
  - 2. Organic Soil Amendment (Compost)
- B. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.
- C. Existing and imported (of needed) topsoil and organic soil amendment for verification:
  - 1. Soil Analysis: Submit copies of soil test results from University of Wyoming Cooperative Extension or Colorado State University Soils Laboratory or similar Qualified Testing Agency as per Section 1.6 below. Submit copies of cover letter / results with recommendations.
  - 2. Fertilizer: Submit copy of fertilizer composition to be used and the Supplier source.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Existing onsite/stockpile AND imported (if required/available) topsoil analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
  - 1. Report suitability of topsoil for bluegrass sod and seed and native seed growth. Provide testing facility recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

## PART 2 - PRODUCTS

### 2.1 PLANTING SOILS

- A. Planting-Soil Type A: Existing, on-site surface soil, with the duff layer, if any, retained and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil

with the soil amendments and fertilizers recommended by the Soil Testing Laboratory Recommendations.

- B. Planting-Soil Type B: If quantities of existing onsite topsoil do not meet the required / needed topsoil, Contractor to provide imported, naturally formed soil from off-site and modified as necessary to produce viable planting soil.
  - 1. Sources: Topsoil should not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.
  - 2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 2 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
  - 3. Unacceptable Properties:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
    - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding two-inch (2") in any dimension.
  - 4. Amended Soil Composition: Blend existing and imported (only if needed) existing, un-amended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
    - a. Organic Soil Amendment: See 2.2 below.

## 2.2 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance".
- B. Organic Amendment shall be Class 1 Compost, meeting the specifications and guidelines established by the Rocky Mountain Organics Council.
- C. Soil Amendments required in bluegrass sod and planting bed areas ONLY.

## 2.3 FERTILIZERS

- A. Provide commercial fertilizers as recommended by the 3rd party for the onsite soils and if necessary imported topsoil as follows:
  - 1. Weight of Superphosphate: As / if required if 3<sup>rd</sup> party testing analysis recommends this additive.
  - 2. Weight of Commercial Fertilizer: As / if required if 3<sup>rd</sup> party testing analysis recommends this additive.
  - 3. Weight of Slow-Release Fertilizer: As / if required if 3<sup>rd</sup> party testing analysis recommends this additive.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Place / replace planting soil and soil amendments per requirements in this specification.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

### 3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: See Earthwork specifications.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a maximum of eight-percent (8%) by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

### 3.3 PLACING AND MIXING PLANTING SOIL (EXISTING OR IMPORTED) OVER EXPOSED SUBGRADE

- A. General: Apply and mix with unamended soil (existing or imported) with soil amendments on-site to produce required minimum, compacted planting soil depth. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of eight-inches (8"). Remove stones larger than one-inch (1") in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off the School District property.
- C. Mixing: Spread un-amended soil to total a minimum compacted depth of six-inches (6") or as specified in Civil Engineer's Earthwork specifications, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Amendments: Apply soil amendments and fertilizers (if required), evenly on surface, and thoroughly blend them with un-amended soil to produce planting soil.
    - a. Mix fertilizer with planting soil no more than seven (7) days before planting.
  - 2. Lifts: Apply and mix un-amended soil and amendments in lifts not exceeding six-inches (6") in loose depth for material compacted by compaction equipment, and not more than four-inches (4") in loose depth for material compacted by hand-operated tampers OR as specified by Civil Engineers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density per ASTM D 698 and tested in-place.

- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.4 APPLYING COMPOST TO SURFACE OF PLANTING SOIL TYPE 'A' AND 'B'

- A. Application: Apply compost at the rate of 3 cu.yds. / 1,000 sq.ft. to surface of in-place planting soil in turfgrass sod and seed areas, and planting bed areas ONLY. Compost materials not required in native seeded areas. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: The School District will engage a qualified testing agency to perform tests and inspections as needed.
- B. Perform the following tests and inspections:
  - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing per ASTM D 698. Space tests at no less than one (1) for each 2500 sq. ft. of in-place soil or part thereof.
- C. Soil will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

### 3.6 PROTECTION AND CLEANING

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off the School District's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by the School District.

END OF SECTION



## SECTION 329200 - TURF AND GRASSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Irrigated and / or Non Irrigated Native Seeding
  - 2. Irrigated Bluegrass Sodding
  - 3. Warranty
  - 4. Turf Maintenance – thru Substantial Completion
- B. Related Sections
  - 1. Division 31, "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling (per civil engineer) and site clearing.
  - 2. Division 32, "Earthwork" for grading, excavation, sub-grade, soil stabilization and treatment, slope protection and surface contouring.
  - 3. Division 32, "Irrigation Systems" for sprinkler irrigation.
  - 4. Division 32, "Plants" for border edgings and plantings.
  - 5. Division 32, "Soil Preparation" for topsoil, soil amendments, fertilizers, etc.
  - 6. Division 32, "Hydro Mulching" for native seed mulching requirements / procedures.

#### 1.3 DEFINITIONS

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. 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" and drawing designations for planting soils.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed.
  - 1. Certification of each native grass seed mixture.
- B. Product certificates.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and seed establishment.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 2. Pesticide Applicator: State licensed, commercial.

## 1.6 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. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within twenty-four (24) hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

## 1.7 SUBSTITUTIONS / ALTERNATES

- A. Products specified herein shall be the basis of design. Substitutions for specific materials will be accepted except under the following conditions.
  - 1. Alternative proposals must be fully supported by necessary documentation showing compatibility/comparability with specific materials. Substitution requests must also comply with the General Conditions.

## PART 2 - PRODUCTS

### 2.1 NATIVE SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species, as follows:
  - 1. Type 1:
    - a. Native Seed Mix containing the following species diversity:
      - Blue Grama (warm season)
      - Buffalograss (warm season)
      - Sideoats Grama (warm season)
      - Western Wheatgrass (cool season)
      - Green Needlegrass (cool season)
      - Sand Dropseed (warm season)
    - See 3.2, B.1. below for Seed Rate
  - b. Or approved alternate seed mix. See 1.7 above.

2. Type 2:
  - a. Wet Meadow (Detention Area) Seed Mix containing the following species diversity:
    - Alkali Bulrush
    - Canada Wildrye
    - Switchgrass
    - Indiangrass
    - Prairie Cordgrass
    - Soft Stem Rush
    - Three Square Bulrush
    - Hardstem Bulrush
    - Nebraska Sedge
    - Baltic Rush
    - Creeping Spikerush
    - Woolly Sedge

See 3.2, B.1. below for Seed Rate
  - b. Or approved alternate seed mix. See 1.7 above.

## 2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Utilize "Big Roll" where possible.
- C. Turfgrass Species: 100% Bluegrass
  1. Not less than 95 percent germination
  2. Not less than 85 percent pure seed
  3. Not more than 0.5 percent weed seed
- D. Provide a sod that includes a minimum of four (4) seed types to include, at a minimum, the following design blend characteristics:
  1. Extensive, Strong & Aggressive Rhizome System
  2. Full Sun & Partial Shade
  3. Cold & Heat Tolerant
  4. Fine & Medium Leaf with Dark Green Color
  5. Durable Surface for High Traffic
  6. Faster Recovery & Self-Healing
  7. Drought Tolerant & Pest Resistant

## 2.3 FERTILIZERS

- A. Native Seed Areas: Commercial fertilizer not required for initial native seed installation / grow-in.
- B. Bluegrass Sodded: Not required unless Substantial Completion is not attained with sixty (60) days of installation. At that time, Contractor shall be required to provide a commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, fifty-percent

(50%) derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. As required by 3<sup>rd</sup> Party testing recommendations.
2. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of fifty-percent (50%) water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - a. Composition: twenty-percent (20%) nitrogen, ten-percent (10%) phosphorous, and ten-percent (10%) potassium, by weight or as required by 3<sup>rd</sup> party testing recommendations.

## 2.4 MULCHES

- A. Straw Mulch: Not allowed.
- B. Hydro Mulch: Native Seeded Areas – See Section 329213 – Hydro Mulching

## 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.

## PART 3 - EXECUTION

### 3.1 SEEDING AND SODDING AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation".
- B. Reduce / increase elevation of planting soil to allow for soil thickness to facilitate sod or seed.
- 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 Owner's Representative acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.2 SEEDING

- A. Definitions.
  1. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Seed Rate / Schedule:
  1. Type 1 Irrigated Seed: 15 lbs. / acre
  2. Type 2 Wet Meadow Mix: 10 lbs. / acre

- C. Seed areas indicated on Drawings and other areas disturbed by construction. Re-work previously prepared areas that have become compacted or damaged by rains or traffic.
- D. Hydro Seeding will not be allowed, rather, apply by means of a Brillion mechanical power drawn drill seeder to a maximum depth of ¼ inch followed by packer wheels or drag chains to provide smooth finish. Seed in two (2) passes at right angles to one another. Sow half of the seed in each pass. Provide markers or other means to assure that the successive seeded strips will overlap or be separated by a space no greater than the space between rows planted by the equipment being used.
  - 1. Do not sow wet seed or seed that is moldy or otherwise damaged.
  - 2. Do not seed against trees / limit extent of seed to outside edge of planting saucer.
  - 3. Sow seed at a rate as recommended by the Seed Supplier.
- E. Broadcast seed in areas that are inaccessible or too steep to drill or as indicated on plans. Broadcast seed in two opposite directions. Spread seed with tackifier first then hydro mulch on top of seed.
- F. Restore fine grade after seeding as requested by the Owner's Representative. Cover seed to depth of 1/4 inch by raking or dragging.
- G. Firm seeded areas with a roller weighing maximum of 100 lbs. per foot of width. Seed application rates shall be as specified.
- H. Hydro mulch consisting of a homogeneous mixture of water, fiber mulch, and non-asphaltic tackifier shall be applied where broadcast seeding applications occur. See Specification 329213 – Hydro Mulching for additional requirements.
- I. Do not sow immediately following rain, when ground is too dry, when ground is frozen or untillable, or during windy periods.
- J. Selection of the time of seeding shall be Contractor's responsibility, consistent with germination and erosion control requirements.
- K. Protect seeded areas from hot, dry weather or drying winds by applying hydro mulch within 24 (twenty-four) hours after completing seeding operations. Soak areas, and roll surface smooth as / if needed.

### 3.3 SODDING

- A. Lay sod within twenty-four (24) hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across slopes exceeding 3:1.

- C. Saturate sod with fine water spray within two (2) hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

### 3.4 TURF MAINTENANCE

- A. General: Contractor to maintain sodded areas from initial installation through Substantial Completion.
- B. Maintain and establish sod and seeded areas by watering, fertilizing (if this maintenance period exceeds ninety (90) days prior to Substantial Completion) - weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas 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. Apply treatments as required to keep sodded areas 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.
- C. Mow sodded areas (thru Substantial Completion) as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third (1/3) of grass height. Remove no more than one-third (1/3) of grass-leaf growth in initial or subsequent mowings.

### 3.5 WARRANTY / SATISFACTORY GROUND COVER

- A. Sodded Turf installations shall meet the following criteria as determined by Owner's Representative:
  - 1. Satisfactory Sodded Turf: At end of maintenance (thru Substantial Completion) period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to re-establish seeded / sodded areas that do not comply with requirements and continue maintenance until turf is satisfactory.

### 3.6 SEEDED AREA MAINTENANCE

- A. General: Maintain and establish native seeded areas by weeding, mowing, replanting, and other operations. Re-grade and replant bare eroded areas and re-mulch as needed.
- B. Seed Establishment Period:
  - 1. Seed establishment period shall begin upon the notice of "Conditional Acceptance" given by the Owner's Representative in writing and continue until the seed is established.
  - 2. Post "KEEP OFF GRASS" signs until seed is established.

3. Maintenance shall include herbicide weed control as necessary. Do not apply herbicide before the first mowing, do not mow before the majority of seedlings have three leaf blades.
  4. Required coverage for grass seed areas shall be twenty (20) viable live seedlings of the species specified per square foot as measured from five (5) feet directly overhead. Determination of required coverage will be based on a random sampling of the entire project area, and shall consist of a minimum of five samples, each two (2) square feet in area. Bare spots are defined as those areas larger than one square foot which do not meet the required coverage. After the inspection it is the Contractor's responsibility to perform the required maintenance within one (1) week to insure an overall healthy established seeding condition.
  5. The total area occupied by bare spots larger than 0.5 square feet must not exceed ten percent (10%) of the total seeded area. Maximum single bare spot size is one (1) square foot. Any seeded grass areas which do not meet the satisfactory stand of growth qualification shall be reseeded and mulched.
  6. Once the maintenance periods are completed and seed establishment is accepted, the Owner's Representative shall issue a written notice of Final Acceptance. The guarantee period extends for one (1) growing season after Final Acceptance.
- C. Provide weed control as required so that planting is reasonably free of weeds and undesirable grass species, diseases and insects. Utilize a broadleaf weed control product as required and a fall mowing to six-inches (6") depth during the fall season for additional weed control.

### 3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris, created by turf and seeding work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. 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 sod / seed is established.
- C. Remove non-degradable erosion-control measures after grass establishment period or as directed by the School District.

END OF SECTION

## SECTION 329213 - HYDRO MULCHING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes:
  - 1. Hydro Mulching
- B. Related Sections:
  - 1. Section 329200 – Turf and Grasses
  - 2. Section 329300 – Plants

#### 1.02 SUBMITTALS

- A. Quality Control Submittals:
  - 1. Certificates: State, Federal and other inspection certificates shall accompany the invoice for materials showing source or origin. Submit to Owner's Representative prior to acceptance of material.
  - 2. Contractor shall submit specifications for both the hydro mulch and organic tackifier prior to application.

#### 1.03 QUALITY ASSURANCE

- A. Source Quality Control.

#### 1.04 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with best management practices for delivery, storage and handling of material.

#### 1.05 PROJECT / SITE CONDITIONS

- A. Existing Conditions:
  - 1. Grade will have been established and seed will be in place. Repairs to seedbed due to vehicle tracking or erosion must be repaired prior to mulching.
  - 2. Vehicular accessibility on site shall be as directed by Owner's Representative. Repair damage to prepared grounds and surfaces caused by vehicular movement during work under this section to original condition at no additional cost to School District.
- B. Environmental Requirements:
  - 1. Do not apply hydro mulch when wind speed exceeds seven (7) miles per hour.



## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Mulch: Mulch all seeded areas, including those seeded over remaining vegetation, hydro mulch with Conwed 200 and an organic tackifier or approved substitute:
  - 2. Virgin wood cellulose fiber: May not contain any substance or fiber that may inhibit germination or growth of grass seeds and plants.
  - 3. Dye to appropriate color to allow proper metering of application.
  - 4. Fibers must have ability to become evenly dispersed and suspended when agitated in water.
  - 5. When sprayed uniformly on surface of soil, fibers shall form blotter - like ground cover which readily absorbs water and allows infiltration to underlying soil.
  - 6. Weight specifications shall refer only to air dry weight of fibers with a standard moisture content of ten (10) percent.
  - 7. Mulch material shall be supplied in containers not weighing over 100 pounds and showing air dry weight of fibers.
  - 8. Organic tackifier may be supplied with hydro mulch fibers or be added at a later time.
  - 9. Suppliers must certify that laboratory and field testing of product has been accomplished and that material meets all of the forgoing requirements for cellulose wood fiber mulch.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. General - Verify that existing site conditions are as specified and indicated before beginning work under this section.
  - 1. Layout: Seeded areas will be mulched. Mulch placement shall not extend beyond seeded areas by more than five (5) feet.
  - 2. Grades: Verify that grades are as indicated and specified.
- B. Unsatisfactory Conditions: Report in writing to Owner's Representative.
- C. Beginning of installation means acceptance of existing conditions by this Contractor.

### 3.02 PREPARATION

- A. Protection:
  - 1. Be responsible for proper repair to landscape, utilities, walls, pavements and other site improvements damaged by operations under this Section.
  - 2. Pay for repairs made by contractors designated by Owner's Representative.
  - 3. Identify mulched areas requiring protection and erect barriers for proper protection and traffic control.
  - 4. Erosion control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind deposited materials at the site throughout the duration of work.

### 3.03 MULCHING

- A. Hydro Mulching:
  - 1. Mixing: Add cellulose fiber mulch after proportionate quantities of water and other accepted materials have been placed in slurry tank. Mix ingredients to form homogenous slurry.
  - 2. Spraying: Spray apply slurry mulch uniformly over seeded areas using control of mulch as metering agent. Apply at rate of 2,500 pounds per acre plus organic tackifier at rate of 150 pounds per acre. Soil may not be visible through the hydro mulch upon completion of application.
  - 3. Hydro mulching: Do not apply in presence of free surface water resulting from rain, melting snow or irrigation.
- B. Hydraulic Mulching Equipment: Include pump capable of being operated at one hundred (100) gallons a minute and at 100 P.S.I., unless otherwise directed.
  - 1. Provide nozzle adaptable to hydraulic mulching requirements.
  - 2. Storage tanks must have means of calculating volume used or remaining in tank.
- C. Timing: Mulch designated areas immediately following seed placement. Mulch must be placed within forty-eight (48) hours following seeding operation. If sections of seed are placed, mulch should follow each phase of seeding.
- D. Quality Control: Repair or re-mulch areas improperly mulched or damaged by Contractor's negligence, in manner specified. Mulch removed by circumstances beyond the Contractor's control shall be repaired and re-mulched as ordered by Owner Representative. Compensation for re-mulch required by circumstances beyond Contractor's control shall be calculated per the Unit Price in the Bid Form.
- E. The Owner's Representative shall be notified twenty-four (24) hours prior to each application and will determine if coverage is according to specification.

### 3.04 NOTIFICATION OF INSPECTION

- A. Notification: Give notice requesting inspection by Owner's Representative at completion of mulching operation.
- B. Deficiencies: If deficiencies exist, Owner's Representative shall specify such deficiencies to the Contractor who shall make satisfactory adjustments and will again notify the Owner's Representative for final inspection.

### 3.05 CLEANING

- A. Cleaning: Remove material containers and other debris from site. Clean paved and finished surfaces soiled as a result of work under this Section in accordance with directions given by the Owner's Representative. Clean out drainage inlet structures. Remove any accumulated soil from the surface to adjacent paved areas or undisturbed grass areas.

### 3.06 PROTECTION

- A. General: Provide and install barriers as required and as directed by the Owner's Representative to protect mulched areas against damage from pedestrian and vehicular traffic until final acceptance. Contractor is responsible for malicious destruction of mulch caused by others.

END OF SECTION

## SECTION 329300 - PLANTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Plants
2. Fertilizers
3. Plant Maintenance
4. Warranty / Guarantee

B. Related Requirements:

1. Section 329113 "Soil Preparation" for soil amendments (compost and fertilizer), topsoil, etc.
2. Section 329200 "Turf and Grasses" for native seeding and bluegrass sodding.
3. Section 329400 "Planting Accessories" for organic and inorganic mulches, edgings, tree staking, etc.
4. Division 32 – Section "Irrigation" for sprinkler irrigation.

#### 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 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Sample warranty.

## 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by School District for maintenance of plants during a calendar year.

## 1.6 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.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Pre-Planting Inspection. Plant material shall be inspected by the Owner's Representative before planting. Plants for inspection must be in a single location, preferably the project site. Rejected materials must be removed from the site, replaced and re-inspected before planting may begin. If the supplier is a local nursery, tagged plants may be inspected at the nursery.
- B. Photos of the plant material to be obtained from non-local sources maybe be submitted to the Owner's Representative for preliminary inspection. The School District reserves the right to reject plant material at any stage of construction or guarantee period.
- C. Deliver bare-root stock plants within twenty-four (24) hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- D. 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.
- E. Handle planting stock by root ball.
- F. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than eight (8) 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.
- G. Owner's Representatives will inspect staked locations of trees before digging for those plants occur. Owner's Representatives will inspect the location of shrubs in their original containers at

the proposed locations before digging commences. Contact Owner's Representative a minimum of two (2) days in advance.

## 1.8 SUBSTANTIAL COMPLETION / WARRANTY

- A. Substantial Completion Inspection. As soon as planting is complete, a review and preliminary inspection to determine the condition of the vegetation will be held by the Owner's Representatives upon request by the Contractor. Is a second substantial completion review is required due to incomplete work, the Contractor is responsible for the additional costs incurred by their Consultants.
- B. The inspection will occur only after the following conditions have been met: Planting is completed; sod has been installed; seeding is complete; irrigation systems shall be fully operational with heads properly adjusted; landscape areas shall be free of weeds and neatly cultivated; plant basins in sodded or seeded areas shall be in good repair; trees staking and guying is complete; construction debris and litter shall be cleaned up and walkways and curbs shall be swept, and cleaned of soil and other debris remaining from planting operations.
- C. If after the inspection, the Owner's Representative is of the opinion that the work has been performed as per the Contract, and that the vegetation is in satisfactory growing condition, a written Notice of Acceptance will be given and the Guarantee Period shall begin.
- D. Any work requiring corrective action in the judgement of the Owner's Representative from the substantial completion inspection, shall be performed within the first ten (10) days of the guarantee period. Any work NOT performed within this time period will necessitate an equivalent extension of the guarantee period. Corrective work and materials replacement shall be in accordance with the original specifications and shall be made at no additional costs to the Owner.
- E. End of Guarantee Period Inspection. At the end of the first full growing seasons, the Owner's Representatives will inspect plant material for satisfactory condition. The inspection shall take place in September and the Owner's Representative shall contact the Contractor concerning any replacements. Replacements may take place in the Fall or during the following Spring if deemed proper or necessary.

## 1.9 PLANT MATERIAL GUARANTEE / WARRANTY PERIOD

- A. Provide a one-year warranty from the date of Substantial Completion. Substantial Completion is hereby defined as the point at which the Landscape Contractor is 100% Complete with the installation and is ready for the Substantial Completion Inspection, as defined above. The Owner's Representative will have sole authority to grant Substantial Completion. The minimum one-year warranty includes all aspects of this section, including installation and materials.
  - 1. Guarantee includes insect infestation or infection by disease organisms.

2. Replacement plantings for trees shall be done in the Spring planting season, except as approved otherwise. If a tree is in marginal condition at the end of the guarantee period, it may be agreeable to both parties to wait until the end of the growing season before deciding whether to replace that tree or not.
3. Replacements shall be of the same kind and size as originally specified. Repairs and replacements shall be made at no expense of the School District.
4. Plant materials that are replaced during this period shall be replaced one (1) time at the Contractor's expense. Cost of subsequent replacements, if required, shall be negotiated with the Owner's Representative. Warranty replacement plant materials planted within six (6) months after Substantial Completion shall have the same end of warranty as the original installation. Plants replaced within six (6) months of the end of the warranty shall be warranted as additional six (6) months after the date of completion of the initial warranty period.
5. It is the responsibility of the Landscape Contractor to monitor the ongoing District maintenance of the project during the warranty period. If the Landscape Contractor finds fault with the District's ongoing maintenance activities, they shall immediately bring to the attention of the Owner's Representative. The Warranty will in no way be invalidated because of the activities of the School District, unless approved by the Owner's Representative.

## 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 per ANSI Z60.1. Root flare shall be visible before planting.

### 2.2 FERTILIZERS – Not required.

## PART 3 - EXECUTION

### 3.1 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Before planting, obtain Owner Representative'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 a minimum of two (2) times as wide as ball diameter.
  - 3. Excavate at least twelve-inches (12") wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
  - 4. 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. See Soil Preparation - Section 329113 for additional information.

### 3.3 TREE AND SHRUB 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 one-inch (1") above adjacent finish grades.
  - 1. Backfill: Planting soil See Soil Preparation - Section 329113 for additional information.
  - 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. Balled, Potted and 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. Bare-Root Stock: Support stem of each plant and spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working. Carefully work backfill around roots by hand. Bring roots into close contact with the soil.
  - 6. 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.
  - 7. Fertilizer: Apply slow release fertilizer around the root ball diameter of the plant. Apply at the Manufacturer's recommended rate.
  - 8. Continue backfilling process. Water again after placing and tamping final layer of soil.



9. Stake / Guy deciduous and evergreen trees as detailed on the Drawings. Trees shall be plumb to the finish grade. Use a min., of two (2) stakes per tree.
  10. Wrap deciduous trees with tree wrap from bottom of trunk up to the first major lateral branch. Secure with jute or other material. Install wrap AFTER October 15<sup>th</sup> but no later than December 15<sup>th</sup>. Remove wrap between mid-March and mid-April.
- 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 AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by the Owner's Representative.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by the Owner's Representative, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. 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.
- B. Use previously specified 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 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 the School District's operations and others in proximity to the Work. Notify Owner's Representative 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.
- F. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

### 3.7 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article above. 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, Shrubs and Ornamental Grasses: through Substantial Completion.

END OF SECTION

## SECTION 329400 - PLANTING ACCESSORIES

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
  - 1. Concrete Landscape Headers
  - 2. Organic Mulch
  - 3. Inorganic Mulch
  - 4. Tree Stabilization Materials
  - 5. Weed Barrier / Geotextile Fabrics
  - 6. Tree Wrap
  - 7. Planting Soil / Backfill – Trees, shrubs
- B. Related Sections:
  - 1. Division 31 - Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
  - 2. Division 31 - Section "Earthwork" for excavation, filling, and rough grading.
  - 3. Division 32 - Section "Turf and Grasses" for sodding of bluegrass turf and native seeding
  - 4. Division 32 – Section "Plants" for plant material.

#### 1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each of the following:
  - 1. One (1) lb. of inorganic (rock) mulch for each type, color and texture of stone required, in labeled plastic bags. Provide name of Supplier and product name.
  - 2. Submit sample of each proposed organic (bark) mulch type, in a plastic bag. Provide name of Supplier and product name.
  - 3. Weed Barrier / Geotextile Fabric: Submit brand name and model number / name of proposed weed barrier to be used.
  - 4. Tree Stakes, Webbing and Rubber Protective Cap: Submit sample of each.

#### 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants and planting accessories.

## 1.05 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installing accessories only when existing and forecasted weather conditions permit work to be performed per manufacturer's written instructions and warranty requirements.

## 1.06 INSPECTIONS

- A. Site Inspection:
  - 1. Contractor shall notify Owner's Representative prior to start of work.
- B. Substantial Completion Inspection:
  - 1. As soon as planting and planting accessory work is completed, a review and preliminary inspection to determine the condition of the installation will be held by the Owner's Representatives upon request by the Contractor.
  - 2. The inspection will occur only after the following conditions have been met:
    - a. Landscape areas will be free of weeds and neatly cultivated;
    - b. Plant basins shall be in good repair;
    - c. Irrigation systems shall be fully operational with heads properly adjusted;
    - d. Debris and litter shall be cleaned up and walkways and curbs shall be cleaned of soil and debris left from planting operations.
  - 3. If, after the inspection, the Owner's Representative is of the opinion that the work has been performed as per the Contract Documents, and that the vegetation is in satisfactory growing condition, he will give the Contractor Written Notice of Acceptance and the Warranty period shall begin.
  - 4. Work requiring corrective action in the judgment of the Owner's Representative shall be performed within the first ten (10) days of the warranty period. Any work not performed within this time will require an equivalent extension of the warranty period. Corrective work and materials replacement shall be in accordance with the Contract Documents and shall be made by the Contractor at no cost to the Owner.
  - 5. Final approval and Substantial Completion notice will be given when all deficiencies are corrected.

## PART 2 - PRODUCTS

### 2.01 LANDSCAPE HEADERS

- A. Steel Edging: Not required.
- B. Concrete Headers: See the detailing on the drawings for concrete header types and locations.

### 2.02 ORGANIC MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  - 1. Type 1: Shredded Cedar. Install 3" compacted depth minimum. Weed barrier is not required beneath organic mulch.

## 2.03 IN-ORGANIC MULCHES

### A. In-Organic Mulch:

1. Type 1: 4" to 8" dia. Washed River Cobble
  - a. Color: Readily available natural gravel color range as deemed acceptable by the Owner's Representative.
  - b. Depth: One layer that covers 100% of the geo-textile weed barrier fabric. Visually, standing above the mulched plantings bed, no geo-textile fabric should be visible.

## 2.04 TREE STABILIZATION MATERIALS

- A. Tree Stakes - 2" diameter Lodgepole Pine or Metal 'T' stakes with rubber end protectors.
- B. Guy Anchors (for evergreen trees)- 24" long metal "t" posts or approved equivalent.
- C. Guying and Staking Cord – 14 AWG wire with 1/2" x 12" PVC sleeves.
- D. Webbing: 2" nylon webbing or rubberized cloth. No hose permitted.

## 2.05 WEED-CONTROL BARRIERS / GEOTEXTILE FABRICS

- A. General: Non-woven 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.
  1. TenCate Mirafi 140N – Non-woven polypropylene,
    - a. Density: 4 oz. / sq.yd.
    - b. Tensile Strength: 120 lb.
    - c. Tear Strength: 50 lbs.
  2. Or approved substitute.
- B. Fabric required beneath in-organic (rock) mulch beds only. Not required in tree ring saucers.

## 2.06 PLANTING SOIL (BACKFILL) MIX (for trees, shrubs)

- A. Planting Pit Backfill Soil Mix: Two (2) parts on-site soil, one (1) part soil amendment (compost).

## 2.07 MISCELLANEOUS PRODUCTS

- A. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch wide minimum, with stretch factor of 33 percent.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas to receive planting accessories for compliance with requirements and conditions affecting installation and performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and sod and existing exterior plants from damage caused by work.
- B. Provide 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.

### 3.03 LANDSCAPE HEADER INSTALLATION

- A. Steel Edging – Not required.
- B. Concrete Header: See site plan drawings and associated detailing for locations of headers.

### 3.04 PLANTING BED WEED BARRIER INSTALLATION AND MULCHES

- A. Install weed-control barriers before in-organic (rock) mulching per Manufacturer's written instructions. Completely cover area to be mulched (or as described on the Drawings) overlapping edges a minimum of six-inches (6").
  - 1. Material and Seam Treatment: Non-woven fabric with seams pinned.
- B. Mulch backfilled surfaces of planting beds and other areas indicated. Provide mulch ring around trees in turf areas.
  - 1. Organic Mulch: Apply three-inch (3") average compacted thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems. Install organic mulch in all perennial and ornamental grass areas or as indicated on the Drawings. Weed barrier is not required in organic mulch areas.
  - 2. Inorganic (Rock) Mulch: Apply a minimum of one (1) layer average thickness of rock mulch, and finish level with adjacent finish grades. Weed barrier shall not be noticeable from overhead – fill in gaps with smaller cobble (only) material. Do not place mulch against plant stems. Install rock mulch in areas in shrub areas AND within the five-foot (5') "no plant" zone immediately adjacent building, or as identified on the Drawings. Weed barrier is required in all rock / cobble mulch areas.
  - 3. Tree Rings: Apply three-inch (3") average compacted thickness of organic mulch, in a minimum of forty-eight inch (48") diameter circle and finish level with adjacent finish grades. Do not place mulch against plant stems. Weed barrier is not required within tree ring areas.

### 3.05 CLEANUP AND PROTECTION

- A. During installation, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

### 3.06 DISPOSAL

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off the School District's property.

END OF SECTION

## SECTION 330200 - UNDERGROUND UTILITIES

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered includes the locating, uncovering, crossing, protection of, repair to, relocation of, or any other work associated with crossing underground utilities encountered during all construction activities.
- B. Contractor shall provide insurance adequate to cover the cost of all claims against the Owner by private or public utility owners and for damage to utilities. All claims shall be paid and lien releases provided prior to the release of retainage (lien releases required only if claims are filed). If not settled by the Contractor, the Owner will pay the utility companies out of any progress payment or remaining retainage.
- C. The Contractor shall be aware of time requirements for utility companies to complete their work and cannot file a "damage for delay" claim due to any activities by a utility company. The Contractor is responsible for all coordination with the utility company.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 311000 - Site Clearing
- C. Section 312201 - Grading
- D. Section 312316 - Excavation
- E. Section 312316.13 - Trenching
- F. Section 330500 - Manholes
- G. Section 331100 - Water Main
- H. Section 331110 - Water Valves and Valve Boxes
- I. Section 331120 - Fire Hydrants
- J. Section 331150 - Water Service
- K. Section 333100 - Sanitary Sewer Piping
- L. Section 334200 - Storm Sewer Piping
- M. Section 334210 - Culverts
- N. Section 334250 - Storm Sewer Inlets

### PART 2 - PRODUCTS

### PART 3 - EXECUTION :

#### 3.01 GENERAL



- A. The Contractor shall have full responsibility for reviewing and checking all information and data regarding any underground facility, for locating all underground facilities for coordination of the work with the owners of such underground facilities (utilities) during construction, for the safety and protection thereof and repairing any damage thereto resulting from the work. The cost for this work shall be included in the contract bid price.
- B. The Contractor is required to hire a private locating service to identify locations of existing utilities not identified by Wyoming 811 or utility companies.
- C. After the utility companies and private locating services have completed their field locates, the Contractor is responsible for recording and preserving this information. The utility companies may charge the Contractor for "excessive locates" based on the respective utility company's policies. The Contractor is responsible for contacting each utility company to verify any policies and/or charges. Any charges incurred for "excessive locates" shall be at the expense of the Contractor.
- D. The Contractor shall be aware that utility locations shown in the construction plans are approximate. Some prospecting is likely required for locating these in the field.

### 3.02 UNDERGROUND UTILITY LOCATIONS:

- A. Utility locations shall be completed prior to excavation necessary to install the improvements. The Contractor shall locate (uncover) all buried utilities prior to crossing them. This requirement pertains to both utilities that are shown in the plans and those that are marked in the field by the utility owners. The Contractor is responsible for contacting the utility owners to provide these markings. Location procedures and information gathered by the Contractor shall comply with all state laws regarding utility locations. the Contractor must fulfill and meet the requirements of Wyoming Statutes 37-12-304 relating to public utilities; providing definitions; providing that notice of intended excavation be given to the public utilities with underground facilities located in the area of the proposed excavation; and providing for exceptions.
- B. The Contractor shall provide access to the buried utility that he has located for the Architect/Engineer to survey and inspect.
- C. Contractor must excavate ahead of the installation when a utility or other obstacle is expected to be encountered at the approximate depth of the pipeline, to allow for adjustments in the grade of the pipeline. Performing utility locations include underground utilities that are close to the facilities being installed. Locating of water, sanitary sewer, storm drain lines, or other underground utilities that are to be connected into, are subsidiary to their associated bid items.

### 3.03 EXISTING UNDERGROUND UTILITIES:

- A. Existing underground utility lines and service connections are generally shown in the plans, but the Contractor shall be solely responsible for locating all existing underground utilities as described in this Section.
- B. After utility locates have been performed by the utility owner or locating service, the Contractor shall locate (uncover) the utility, by careful prospecting.
- C. Contractor is solely responsible for supporting the existing utilities if support is needed, or as directed by the Architect/Engineer.
- D. Contractor is solely responsible for protection of and repair of any damage thereto as a result of their excavation or construction activities.
- E. The Contractor shall record the size, location and depth of the utility crossing for the compilation of record drawings and allow the Architect/Engineer the opportunity to do the same.

END OF SECTION 330200

## SECTION 330500 - MANHOLES

### \$PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered consists of furnishing and installing all manholes and accessories at locations as specified herein and indicated in the construction plans.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312316.13 - Trenching
- C. Section 330200 - Underground Utilities
- D. Section 331100 - Water Main
- E. Section 333100 - Sanitary Sewer Piping
- F. Section 334200 - Storm Sewer Piping

#### 1.03 RESPONSIBILITY FOR MATERIAL:

- A. The Contractor shall be responsible for all such material furnished by them and shall replace, at their own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the work or during the one-year correction period.
- B. The Contractor shall be responsible for the safe storage of material furnished by them, to them, and accepted by them and intended for the work. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

#### 1.04 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these specifications.

### PART 2 - PRODUCTS

#### 2.01 MANHOLES:

- A. Manholes shall be constructed of precast reinforced concrete using Type I-II SR cement. Reinforced concrete manhole sections shall conform to the requirements of standard specifications for Precast Reinforced Concrete Manhole Sections, ASTM C478. All manholes should be capable of withstanding HS-20 loadings.
- B. The bottom section of sanitary sewer and storm drain manholes shall be cast with circular openings or horseshoe-shaped block outs, if allowed by the Plans, to accommodate the particular size or type of pipe or angle of turn in the line, as required. The bottom section of air release manholes shall be cast with horseshoe-shaped block outs. The bottoms of sanitary sewer, storm drain, or other manholes that are intended to be watertight, are to be poured monolithic with the bottom wall section.

- C. The upper section of the manhole shall be either a cone section or straight section, as indicated in the construction plans. Cone sections shall be 2 feet tall.
- D. Grade adjustment rings may be used for adjustment of the frame and cover to finish grade. Precast concrete grade adjustment rings shall not be used.
- E. Grade adjustment rings that are manufactured from ARPRO® Expanded Polypropylene (EPP), black, 5000 series meeting ASTM D3575 and ASTM D1248, or an approved equal, shall be used. The rings shall be manufactured using a high compression molding process to produce a finished density of 120 g/l (7.5 pcf). Specifications for EPP adjustment rings shall be as follows:
  - 1. "Grade" adjustment rings may contain either an upper and lower keyway (tongue and groove) for vertical alignment and/or an adhesive trench on the underside with a flat top.
  - 2. "Finish" or "Flat" rings may either have a keyway (groove) on the underside for vertical alignment and/or an adhesive trench with a flat upper surface. These rings shall be available in heights (thicknesses) which will allow final adjustment of the frame and cover or grate to within 1/4 inch to 1/2 inch of the specified final elevation.
  - 3. "Finish" rings may also have a keyway on the upper surface of the inner diameter to facilitate installation of an "Angle" ring.
  - 4. "Angle" rings may either have an upper and lower keyway (tongue and groove) for vertical alignment and/or an adhesive trench on the underside. When required, the "Angle" ring(s) shall allow final adjustment of the frame and cover or grate to within 1/2 inch of the specified final elevation.
- F. Any adhesive or sealant used for watertight installation of the EPP grade adjustment rings shall be M-1 Structural Adhesive/Sealant or equal meeting the following specifications:
  - 1. ASTM C920, Type S, Grade NS, Class 25, Uses NT, T, M, G, A and O,
  - 2. Federal Specification TT-S-00230-C Type II, Class A,
  - 3. Corps of Engineers CRD-C-541, Type II, Class A,
  - 4. Canadian Standards Board CAN 19, 13-M82, or
  - 5. AAMA 802.3-08 Type II, AAMA 803.3-08 Type I and AAMA 805.2-08 Group C.
- G. Mortar used to further adjust EPP grade rings shall be a one-component, quick-set, high strength, non-shrink, polymer-modified cementitious patching mortar, which has been formulated for vertical or overhead use meeting the requirements of ASTM C109/C109M for Compressive Strength, ASTM C348 for Flexural Strength and ASTM C882/C882M for Slant Shear Bond Strength. Repair mortar shall not contain any chlorides, gypsums, plasters, iron particles, aluminum powder or gas forming agents, nor shall it promote the corrosion of any steel that it may come in contact with. All mortar shall be used within 40 minutes after mixing. Mortar which has begun to take on initial set shall be discarded and shall not be mixed with additional cement or new mortar.
- H. Cementitious grout shall be a premixed, non-metallic, high-strength, non-shrink grout which meets the requirements of ASTM C191 and ASTM C827/C827M, as well as CRD-C-588 and C-621. When mixed to a mortar or "plastic" consistency, it shall have minimum 1 day (6,000 psi) and 28 day (9,000 psi) compressive strength.
- I. Joints between precast manhole wall sections shall be made with a butyl rubber sealant such as ConSeal CS-102, or an approved equal. Tylox Type A rubber pipe gaskets as manufactured by Hamilton-Ken Mfg. Co., Kent, Ohio, or O-ring gaskets which will meet the requirements of ASTM C443 or an approved equal will be accepted as equal to ConSeal CS-102 plastic joint filler. Jointing shall be in strict accordance with the plastic filler or gasket manufacturer's recommendations.
- J. Manhole joints shall be wrapped around their entire circumference with a polyolefin-backed exterior joint wrap. The joint wrap shall be ConSeal SC-212 or approved equal.

- K. Floors in the manholes for air release valves shall consist of washed gravel bedding material 12 inches thick that extends at least one foot outside the manhole wall to support the manhole and to allow free drainage. The openings for the pipelines shall be precast knockouts. Vent pipe openings can be cast in place or can be drilled in the field. Electrical insulation/cushion shall be provided where the pipe extends through the precast manhole opening with the use of a rubber pad.
- L. The manhole shall be substantially free of fractures and surface roughness. The planes of the ends of the manhole sections shall be perpendicular to their longitudinal axis, within the limits as specified in ASTM C478/C478M.
- M. If necessary, manhole sections may be repaired if in the opinion of the Architect/Engineer the repairs are sound and properly finished and cured and the repaired manhole sections conform to the requirements of the Specifications.
- N. Sanitary sewer manhole channels and benches shall be constructed using fiber-reinforced plastic (FRP) manhole base liners, which shall be monolithically cast within the manhole base. The base liner shall be the Perfect Lined Manhole System, or approved equal, and shall be installed in accordance with the manufacturer's recommendations.
- O. Drop manholes shall be internal drops and provided when indicated in the construction plans. All drop manholes shall be Reliner internal drop manholes, or approved equal.

## 2.02 MANHOLE STEPS:

- A. Manhole steps are to be cast or drilled and mortared into the walls of the manhole, and designed to withstand a minimum concentrated live load of 400 lb. The live load shall be considered to be concentrated at such points as to cause the maximum stress in the structural member being considered. The steps shall have a minimum cross section of 3/4-inch. The steps shall be imbedded into the manhole wall a minimum of 3 inches with a pull-out resistance of 1,000 lb. The materials used in the steps shall be 1/2-inch Grade 60 steel with a polypropylene plastic coating, complying with ASTM C478. The step shall be free of splinters, sharp edges, burrs, or projections which may be a hazard to persons using the steps for access into or out of the manhole. Minimum width of rungs shall be 12 inches. The rung shall also project a minimum of 5-3/4 inches from the wall, measured at the point of embedment. Steps in the manhole sections shall be aligned so as to form a continuous ladder with rungs equally spaced vertically in the assembled manhole at a maximum distance of 12 inches apart. The manhole steps shall comply with ANSI 14.3. The maximum height distance from the surface to the first step shall be no greater than 30 inches.

## 2.03 MANHOLE FRAMES AND COVERS:

- A. All cast iron manhole frames and lids shall be made conforming to the requirements of ASTM A48/A48M Class 35 and shall be free from cracks, swells, holes and cold shuts, and shall have a smooth finish. Castings shall conform in all dimensions to the plans. Before leaving the foundry, all casting shall be thoroughly cleaned and subjected to a hammer test
  - 1. Air Release Manholes (or other manholes used on the water system):
    - a. Frames and covers shall be frost-free design. Unless otherwise noted, the manhole frame shall be Neenah No. R-1755F2, with a Design C surface, or approved equal, with the word "WATER" cast on the lid.
  - 2. Sanitary Sewers:

- a. Frame and cover shall be Neenah R-1649, Deeter 1258, D&L Foundry A-1071 (4 inch), A-1043 (6 inch), A-1161 (8") ring with A-1161 cover, or approved equal, with the words "SEWER" cast on a non-venting, Type C lid. The cover shall be 23-7/8 inches with a 22-inch opening. It shall be rated for HS-20 loading. The cover shall have a vented opening such as a Denver opening, or approved equal, with one pick hole. Existing sanitary sewer manhole covers will not be allowed to be used as replacement lids in areas where existing manholes are to be removed unless allowed by the Plans.
- 3. Storm Drains:
  - a. Frame and solid cover shall be Neenah R-1649, Deeter 1258, D&L Foundry A-1071 ring with A-1161 cover or approved equal, with the words "STORM" cast on a vented, Type C lid. The cover shall be 23-7/8 inches with a 22-inch opening. It shall be rated for HS-20 loading. The cover shall have a vented opening such as a Denver opening or approved equal with one pick hole. Existing storm drain manhole covers will not be allowed to be used as replacement lids in areas where existing manholes are to be removed unless allowed by the Plans.
  - b. Frame and grated cover shall be EJ Innovative Access Solutions Series No. 1020 Frame and Type M3 ADA Grated 22-3/4 inches Cover with a 21-inch opening, D&L Foundry A-1032 Frame with C-1043 Grated 23-7/8-inches cover, or Architect/Engineer approved equivalent. It shall be rated for HS-20 loading.

#### 2.04 PIPE GASKET:

- A. A flexible, watertight seal is to be used between the sanitary sewer pipe and the concrete manhole (or any manhole on the water system that is intended to be watertight), where the pipe passes through the manhole wall. This is to be a PSX Gasket with power sleeve and take-up clamp, Alok Gasket, or approved equal. Storm drain pipe to manhole transition shall be a grouted connection.

### PART 3 - EXECUTION

#### 3.01 MANHOLE INSTALLATION:

- A. Manholes shall be constructed to the general dimensions shown in the Construction Plans. Base gravel is to be placed as shown in the Construction Plans. Manhole inverts shall be within 0.04 feet of their design elevation.
- B. The manhole frame shall be adjusted to finished grade through the use adjusting rings made of HDPE conforming to ASTM D1248 and shall be ARPRO® Expanded Polypropylene (EPP), black, 5000 series adjusting rings, or approved equal using the procedure detailed in within this Section. Total combined height of the manhole ring and adjusting rings shall not exceed 16 inches. If an equal adjusting ring is approved for use, it shall be installed according to all instructions of its manufacturer. The rings shall be sealed according to the ring manufacturer's recommendations. The process of simply setting the adjusting rings in place and setting the cast iron ring on top of the grade rings without using any bonding or setting agent will not be allowed. No concrete adjusting rings, and no wood material, or other material subject to deterioration, shall be used to adjust manhole frames to finished grade. No more than 8 inches of adjusting rings shall be permitted. If a greater adjustment is needed, the upper section shall be removed and the adjustment made through the use of intermediate manhole sections.

- C. Invert channels of sanitary sewer manholes, which are precast, shall be very smooth, PVC-lined and semi-circular in shape conforming to the inside of the adjacent sewer sections. Where side branches or change in direction, grade, or diameter occur in the manhole, manufacturer's pipe fittings or carefully mitered sections of straight pipe may be used. Construction by laying the pipe through the manhole with glue-type fittings, and cutting top half of pipe out may be allowed by the Architect/Engineer. Inverts shall provide a minimum of 0.1 foot drop in a manhole angled from 90° to 270° and 0.2 foot drop for manholes angled less than 90° or greater than 270°. The floor of the manhole outside the channel shall be smooth and shall slope toward the channel not less than 1 inch per foot nor more than 2 inch per foot. Pipe crown elevations shall match when the upstream line is smaller in diameter than diameter in the downstream sewer line. All lifting holes must be grouted. The channel shall be approved by the Architect/Engineer to ensure the camera and maintenance equipment can be utilized in the manhole. If the camera or maintenance equipment cannot get into the newly installed channel, the Contractor shall remove and replace the invert to the satisfaction of the City at the expense of the Contractor.
- D. At the circular opening through the manhole wall, the PSX Gasket, or approved equal, is to be installed for a watertight connection on sanitary sewer pipes, or elsewhere as required.
- E. All sanitary sewer connections between manhole sections are to be watertight.
- F. Storm drain connections between manhole and pipe shall be a grouted smooth and watertight from both the inside and outside.

### 3.02 MANHOLE ADJUSTMENT:

- A. Existing Manhole frames and covers shall be adjusted through the use of grade rings or the removal and replacement of the riser sections as determined by the Architect/Engineer. If the total adjustment, including the existing rings, is in excess of eight inches, an existing manhole section shall be replaced with a new section having the correct dimensions, or an additional section added. Contractor shall verify the size and quantity of rings that will be required at each manhole to facilitate the adjustment.
- B. For installation of the ARPRO® Expanded Polypropylene (EPP), black, 5000 series adjusting rings, the following procedure shall be used:
  - 1. Installation surface preparation shall be in accordance with the manufacturer's instructions.
  - 2. The joint between the first grade ring and top of the manhole shall be sealed using an adhesive/sealant meeting the requirements of Part 2 of the Section.
  - 3. If the top of the manhole is not level or is irregular, then a non-shrink repair mortar, or a non-shrink cementitious grout, meeting the requirements of Part 2 of this Section shall be used. A bed of the specified mortar or grout shall be placed on the top surface of the manhole and then the first grade ring shall be embedded and leveled into the bed of material.
  - 4. The remaining joints between all manhole adjustment rings and the frame and cover shall be sealed using an adhesive/sealant meeting the requirements of Part 2 of this Section.
  - 5. No other materials shall be used in the construction of the grade adjustment area beyond those specified above. Prohibited materials include, but are not limited to, wood or wood shims of any kind, concrete, brick, block, stones, etc.
  - 6. The use of any heat-shrinkable chimney seals shall not be permitted.

### 3.03 EXISTING MANHOLE REMOVAL:

- A. The Contractor shall excavate and remove all existing manholes as specified in the construction plans. The manhole, frame and cover shall be removed and disposed of by the Contractor. The backfill of the existing manhole shall be with 3-inch minus pit run material. Filling of the manhole and removal of only the cone section and ring and cover will not be acceptable.

#### 3.04 TIE TO EXISTING MANHOLES:

- A. The Contractor shall make all required ties to existing manholes as neat as possible. The tie shall be made by saw cutting or chiseling out a hole in the location of the new sanitary sewer or storm sewer pipe. Large equipment such as track or rubber tire excavators shall not be used to knock a hole in the manhole. The manhole/new pipe connection shall be encased with concrete on the outside of the connection, and grouted on the inside. This connection shall be watertight.
- B. The Contractor shall provide a new very smooth flow line inside the existing manhole to direct flow in the designated direction. All existing formed flow lines that are to be abandoned and any abandoned invert(s) shall be grouted watertight.

#### 3.05 CONFINED SPACE ENTRY:

- A. The Contractor shall satisfy confined space entry requirements for the Architect/Engineer and the City to enter manholes and vaults. The requirements shall include furnishing and operating air quality testing equipment, furnishing and operating air movement equipment, furnishing communications equipment, and furnishing and operating other equipment and manpower to satisfy confined space entry requirements.
- B. The Contractor shall be trained in confined space entry prior to entering any confined space.

#### 3.06 DURING CONSTRUCTION:

- A. Following installation of the manhole, a plywood sheet or similar material shall be laid across the bottom of the manhole (above the flow line through the manhole) to prevent dirt and gravel from entering the sanitary sewer or storm sewer pipe(s). This shall be removed with the manhole invert and adjoining pipes thoroughly cleaned, prior to final acceptance. When paving, a metal plate shall be placed over the top of the manhole opening to prevent material from falling into the manhole. Contractor shall remove any dirt, gravel or other construction debris from the manhole and adjacent pipes.
- B. Contractor shall use whackers or similar equipment to assure compaction around the manholes meets requirements outlined in Section 312316.13 - Trenching.

#### 3.07 CONCRETE "DIAMOND" COLLARS:

- A. Concrete collars, or "diamonds", shall be installed per the construction plans if the new or adjusted manhole is being placed in a paved or open area. Concrete collars shall NOT be installed in unpaved gravel areas (e.g. alleyways). In such cases, the manhole cover shall be left 4-inches to 6-inches below the unpaved gravel surface.
- B. If settlement of a manhole lid installed at grade in a paved area exceeds 1/4 inch after one year, the Contractor will be required to adjust the manhole to grade and install a replacement concrete collar at no cost to the Owner.

#### 3.08 Utility Markers



- A. All manholes located outside of a roadway or hardscaped area shall be marked with a Utility Marker.

END OF SECTION 330500

## SECTION 330510 - ADJUSTING EXISTING UTILITY STRUCTURES

### PART 1 - GENERAL

#### 1.01 SUMMARY:

- A. The work covered by this section shall consist of locating and adjusting existing manholes, cleanouts, inlets, utility valves, gas valves, water valve boxes, water service curb stops, fire hydrants or other appurtenances to the grade shown in the construction plans.

#### 1.02 RELATED WORK

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312201 - Grading
- C. Section 312316.13 - Trenching
- D. Section 330500 - Manholes
- E. Section 331110 - Water Valves and Valve Boxes
- F. Section 331120 - Fire Hydrants
- G. Section 331150 - Water Service
- H. Section 334250 - Storm Sewer Inlets

### PART 2 - PRODUCTS

#### 2.01 MATERIAL

- A. All material, such as concrete and grout shall meet specifications as required in the section on the particular material involved, or if the material is not covered in these specifications, the material used for adjusting shall be equal, and comparable to that in the existing structure, as approved by the Architect/Engineer. If extensions for water valve boxes or services and fire hydrants are required beyond the length found to exist, extensions that comply with these specifications shall be provided and shall be considered subsidiary to this work.

### PART 3 - EXECUTION

#### 3.01 METHOD OF CONSTRUCTION

- A. All existing manholes, cleanouts, inlets, utility valves, gas valves, water valve boxes, water service curb stops, fire hydrants or other appurtenances shall be brought to grade by either lowering or raising, as required, to the grades shown in the Plans. Where lowering of manholes, cleanouts or inlets is required, care shall be used in removing the top portion of the masonry or pipe. Before the ring and cover is replaced, the top of the masonry on the manhole, cleanout, or inlet must be true to line and grade.
- B. Water valve boxes shall be excavated and exposed so as to readily determine whether height adjustment can be made without substituting a longer section. Water valve boxes shall be adjusted laterally so the valve stem can be operated by the extension. Vertical adjustment shall be made by raising or lowering the extension box as specified in the construction plans.

- C. Manholes, cleanouts, utility valves, gas valves and water valve boxes shall be adjusted to final grade after completion of paving. Preliminary adjustment may be required to allow placing of base courses and paving over the manholes, cleanouts, water valves, or other appurtenances.
- D. Backfill shall be in conformance with Section 312316.13 - Trenching.
- E. Before final acceptance, all manholes, cleanouts, inlets and water valve boxes or services shall be cleaned, and water valve boxes or services and fire hydrants shall be operational.
- F. Concrete collars shall be placed around valve boxes and manhole covers within paved roadways and open areas. If settlement of the roadway around the manhole exceeds 1/4 inch one year after installation the Contractor will be required to adjust the manhole to grade and install a concrete collar at no cost to the Owner.
- G. When installing concrete collars in pavement, the location of the valve boxes and manholes shall be determined (such as by surveying) prior to paving, so the cuts in the asphalt are in the correct location, and the size of these collars does not exceed that allowed.
- H. Rebar shall be placed in the concrete collars around valve boxes and manhole covers as shown in the construction plans.
- I. In areas where excavation has been performed for minor adjustments to valve boxes and manhole covers, and where hand compaction for backfill is unsatisfactory in these excavated areas, flowable fill shall be used instead.

END OF SECTION 330510

## SECTION 331100 - WATER MAIN

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered by this section consists of the construction of water mains, including fittings, and other appurtenances normally used for water supply and distribution systems. This item shall consist of furnishing and installing pipe and fittings, construction of thrust blocking, and other related work.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 033100 - Site Concrete Work
- C. Section 311000 - Site Clearing
- D. Section 312316.13 - Trenching
- E. Section 330200 - Underground Utilities
- F. Section 330510 - Adjusting Existing Utility Structures
- G. Section 331110 - Water Valves and Valve Boxes
- H. Section 331120 - Fire Hydrants
- I. Section 331150 - Water Service
- J. Section 331200 - Corrosion Protection of Plastic Pipe Systems
- K. Section 331210 - Disinfecting Water Piping Systems
- L. Section 340100 - Temporary Traffic Control

#### 1.03 REFERENCE STANDARDS

- A. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- B. ASTM A285/A285M - Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength.
- C. ASTM A512/512M - Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing.
- D. ASTM C272/C272M - Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions.
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- F. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- G. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics.

- H. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- I. ASTM D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
- J. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- K. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- L. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
- M. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- N. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
- O. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
- P. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
- Q. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- R. AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
- S. AWWA C207 - Steel Pipe Flanges for Waterworks Service, Size 4 In. Through 144 In. (100 mm Through 3,600 mm).
- T. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
- U. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm).
- V. AWWA C907 - AWWA C907-23 Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. (100 mm Through 300 mm).
- W. AWWA M23 - PVC Pipe - Design and Installation.

#### 1.04 RESPONSIBILITY FOR MATERIALS:

- A. The Contractor shall be responsible for all such material furnished by him/her and shall replace, at his/her own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work or during the guarantee period.
- B. The Contractor shall be responsible for the safe storage of material furnished by him/her or to him/her, and accepted by him/her, and intended for the Work, until it has been incorporated in the completed Project. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

#### 1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.

## PART 2 - PRODUCTS

## 2.01 PVC PUSH-ON PIPE

- A. All PVC pipe with a diameter of 4 inches through 60 inches shall meet the requirements of the latest editions of ASTM D2241 and AWWA C900. Pipe shall be DR18, 235 psi pressure class, unless called out otherwise in the plans.
1. Pipe shall be NSF approved for potable water and shall be colored blue.
  2. Pipe shall be marked as specified in AWWA C900. Certification by an independent accredited testing laboratory suitable to the Architect/Engineer that the pipe complies with shall be provided.
  3. Gasketed bell and spigot couplings complying with ASTM D3139, ASTM F477, and AWWA C900.
  4. Laying lengths shall be 20 feet  $\pm$ 1-inch.
- B. Pipe material shall conform to:
1. ASTM D1784/ASTM D1784 Type 1, Grade 1 (12454-B).
  2. Hydrostatic design basis (HDB) of 4,000 psi per ASTM D2837, service factor of 0.5 for hydrostatic design stress (HDS) of 2,000 psi.
  3. Pipe interior shall not be rough. Not less than minimum wall thickness shall be maintained through the entire pipe length.
  4. Material shall be manufactured with all virgin material or reworked material from the same plant which produces the pipe. Use of reworked material shall be within the requirements of AWWA C900.
  5. Pipe shall be free of holes, foreign inclusions, foreign material, surface blemishes or scratches deeper than 10 percent of the wall thickness.
  6. Pipe shall not exhibit excessive weathering or evidence of sun degradation.
  7. The Architect/Engineer may reject any pipe due to concerns of defects including, but not limited to worn gaskets, scratches to the pipe, cracks in the pipe, or other defects as seen by the Architect/Engineer.
  8. The Architect/Engineer may reject any pipe which was manufactured more than one year prior to delivery, or for other causes.
- C. All PVC pipe shall be covered to keep exposure to sunlight at a minimum whenever pipe is stockpiled for more than 4 months.
- D. All pipe shall be ductile iron outside diameter (DIOD).

## 2.02 FITTINGS:

- A. Ductile Iron Fittings: Fittings shall have a minimum Class 250 wall thickness and shall meet all requirements of the latest edition of AWWA C110/A21.10 (standard fittings) or be Class 350 complying with AWWA C153/A21.53 (compact fittings).
1. Fittings shall be either push on or mechanical joint. Flanged fittings may be required in certain applications if called out in the Plans. If MJ or flange fittings are used, all bolts, nuts, and washers shall be series 300 stainless steel.
  2. Fittings shall be fusion-bonded epoxy coated and lined per 331200 - Corrosion Protection of Plastic Pipe Systems.
  3. Cement mortar lining is also acceptable, per AWWA C104/A21.4.
  4. Gaskets shall be per AWWA C111/A21.11.
- B. PVC Fittings: PVC fittings may be used with AWWA PVC pipe with a diameter of 4"-12".
1. The fittings shall be Pressure Class 235 (minimum), injection-molded fittings with push-on rubber gaskets, complying with ASTM D3139, ASTM F477 and AWWA C900 or AWWA C907.
  2. No glued fittings shall be accepted.

- C. Plugs: Plugs shall comply with AWWA C110/A21.10 or AWWA C153/A21.53, with coatings per AWWA C104/A21.4 and AWWA C111/A21.11. Plugs shall be Tyler 5-152, or approved equal.
- D. Couplings: Flexible Couplings shall be of ASTM A53/A53M, ASTM A512/512M, or carbon steel having a minimum yield strength of 30,000 psi.
  - 1. Coating shall be fusion bonded epoxy coated and be a minimum of 10-mils thick or coated with 14-20 mils dry film thickness of high-build epoxy, applied in 2 coats. Surface preparation to be SSPC- SP-10 (near white).
  - 2. Couplings shall be Dresser Style 38 (or 39 insulating couplings, if called for) or Architect/Engineer approved equal.
  - 3. Bolts, nuts and washers are to be series 304 or 316 stainless steel.

#### 2.03 TAPPING SLEEVE

- A. Tapping sleeves shall be made of 3/8-inch carbon steel meeting ASTM A285/A285M, with a fusion bonded epoxy coating with minimum thickness of 10 mils, per Section 331200 - Corrosion Protection of Plastic Pipe Systems.
  - 1. Flanges shall be Class D ANSI 150 lb., complying with AWWA C207.
  - 2. A properly sized gasket is to be provided to create a watertight seal.
  - 3. Bolts and nuts are to be series 300 stainless steel.
  - 4. The tapping sleeves are to be Dresser Style 610, TPS Triple-Tap, or Architect/Engineer approved equal.

#### 2.04 RESTRAINED JOINTS:

- A. PVC Pipe: Restraints on pipe or fittings shall be EBAA Iron Series 2000, or approved equal.
  - 1. They shall be 2000PV, 2800, 2600, or 2500, as appropriate for the installation and whether the restraint is across a pipe joint or connecting a pipe to a fitting or valve.
  - 2. All metal in the restraint shall be stainless steel or coated as noted below.
  - 3. T-bolts and gland bolts shall be stainless steel or coated with 8 mils of fusion bonded epoxy.
  - 4. The installed device shall have a pressure rating equivalent to pipe being joined of at least 235 psi.
- B. Coatings: The coating on mechanical restraints shall be electrostatically applied polyester, 4 mils minimum, following surface preparation of a minimum of an iron phosphate bath, rinse and heat drying, or approved equal.
  - 1. The coating shall be EBAA-Iron Mega-Bond, or approved equal.
  - 2. Wedge assemblies may be Xylan fluoropolymer coated, 2 coats minimum.

#### 2.05 INSULATION BOARD

- A. Where a minimum depth of 5.5 feet of cover cannot be maintained, or as shown in the construction plans, over the water line, rigid, extruded polystyrene insulation board is to be provided.
- B. The board is to comply with ASTM C578 Type IV. The board shall have meet the following:
  - 1. The 5-year aged R-value per inch shall be 5 when tested at 75°F mean temperature (ASTM C518).
  - 2. Min. compressive strength of 25 psi (ASTM D1621).
  - 3. Max. water absorption of 0.1% by volume (ASTM C272/C272M).
  - 4. Max. linear change of 3% (ASTM D2126 ).

- C. The board is to be 2 inches thick with a composite thickness of 4 inches and is to extend out 3 feet from the center of the pipe, unless the depth of cover over the pipe is less than 3.5 feet, then it is to extend 4 feet from the center of the pipe.
- D. The board is to be Dow Styrofoam Brand, or approved equal.

2.06 WARNING TAPE AND TRACER WIRE:

- A. Warning Tape: Non-detectable Warning Tape shall be provided in accordance with Section 312316.13 - Trenching.
- B. Tracer Wire: Tracer wire shall be provided in accordance with Section 312316.13 - Trenching.

2.07 Utility Markers shall be Carsonite Utility Markers, or Architect/Engineer approved equal. The markers shall be made of a blue composite material and be 3-3/4 inches wide and 66 inches long.

2.08 OTHER

- A. Joint Bond Wires and Anodes: Joint Bond Wires shall be single-conductor, stranded copper wire with 600-volt HMWPE insulation. Wires and anodes shall be per Section 331200 - Corrosion Protection of Plastic Pipe Systems.

PART 3 - EXECUTION

3.01 PIPE INSTALLATION (OPEN - CUT METHOD):

- A. Excavation and Backfill: Excavation, backfill and compaction for pipe shall conform to the applicable portions of Section 312316.13 - Trenching.
- B. Handling of Pipe: All pipe furnished by the Contractor shall be delivered and distributed at the site by the Contractor. Pipe, fittings, and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. Handling of pipe is to comply with manufacturer's recommendations. Bands on bundled pipe are to be cut with handheld snips.
  - 1. In distributing the material at the site of the Work, each piece shall be unloaded opposite or near the place where it is to be installed. All material shall be stored in a neat and orderly manner.
  - 2. Pipe with joint rings shall be handled in such a manner that no weight, including the weight of the pipe, will bear on or be supported by the joint rings at any time. Care shall be taken to avoid dragging the spigot ring on the ground or allowing it to come in contact with gravel, crushed stone, rocks, or other hard objects. Joint rings which have been damaged in any way will not be accepted and shall not be incorporated in the Work. Pipe shall be so handled that the coating and lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the Architect/Engineer. All repairs are to comply with manufacturer's recommendations and these Specifications.



- C. Laying Pipe: Before installation, the pipe and pipe coating shall be inspected for defects. Any damage to pipe or coatings shall be repaired as recommended by the pipe manufacturer before laying the pipe. All pipe shall be laid and maintained to the required lines and grades with fittings and tees installed at the required locations, except as adjusted in the field by the Architect/Engineer. When obstructions are encountered during the progress of the work and they are not shown in the Plans, and the obstructions interfere to such an extent that an alteration in the alignment is required, the Architect/Engineer shall have the authority to change the alignment and order a deviation from the line and grade or arrange for the removal, relocation or reconstruction of the obstructions.
1. Trenching, backfill, and compaction shall conform to Section 312316.13 - Trenching.
  2. Proper implements, tools, and facilities satisfactory to the Architect/Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the Work. All pipe and fittings shall be carefully lowered into the trench piece by piece by means of a derrick, ropes, or other suitable tools or equipment, in such a manner as to prevent damage to pipe. Under no circumstances shall materials be dropped or dumped into position.
  3. Water shall not be allowed to accumulate in the trench during the laying of the pipe or in the initial backfill operations. The trench shall be dewatered in accordance with the specifications. The Contractor shall take all necessary precautions to prevent surface water from entering the pipeline trench.
  4. Pipe shall be protected from lateral displacement by means of pipe embedment material installed as provided in Section 312316.13 - Trenching. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.
  5. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipe laying crew cannot put the pipe into the trench and in place without getting earth into it, the Architect/Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. Before final acceptance the Contractor shall remove from the pipe any foreign material which may have gotten into the line.
  6. During laying operations, no debris, tools, clothing or other material shall be placed in the pipe. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug, or other means approved by the Architect/Engineer.
  7. Preparatory to making the joints, the pipe grade and alignment shall be checked and all dirt or other foreign matter shall be removed from the bell or coupling.
  8. PVC pipe shall be installed in accordance with AWWA M23.
  9. All water lines shall be laid with a minimum cover over top of pipe of 5.5 feet unless otherwise specified in the Plans. The minimum cover shall be measured from the final grade or interim grade, whichever is lower.
    - a. Shallow Water Lines
      - 1) Installation of shallow water lines shall only be permitted as shown by the contract documents.
      - 2) All installation procedures shall be reviewed by the Architect/Engineer prior to execution of the work.
      - 3) Pipe insulation shall be installed where called for on the plans or required by the Architect/Engineer. Insulation shall be 8 feet wide by 4 inches thick rigid insulation centered over the pipe. Where shown on the plans or drawings, insulation may be extended vertically on both sides of the pipe.
      - 4) Compact pipe bedding material to top of pipe bell, provide smooth compacted surface for insulation board, center insulation board on pipe, and place 4 to 6 inches of pipe bedding material over insulation board.

- D. Mechanical Joints: The inside of the bell and the outside of the spigot of the mechanical joint fittings shall be brushed thoroughly with a wire brush to remove all loose rust or other foreign material just prior to assembly. The cleaned surfaces shall be brushed with soapy water just prior to slipping the gasket over the spigot end and into the bell.

1. The spigot end of the pipe or fitting shall be accurately centered in the bell before jointing is begun. After the gasket is in place, the gland shall be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the gland. Bolts shall be partially tightened, alternately around the gland, maintaining approximately equal tension until the final tension is reached. The minimum distance between mechanical joint flanges shall be 2.0 feet. The maximum distance shall be 5 feet when fittings are identified as being installed close to each other.
2. The normal range of bolt torques to be applied to the bolts in the joints shall be as follows:

| Bolt Size - (Inch) | Range of Torque (Ft. - Lb.) |
|--------------------|-----------------------------|
| 5/8                | 40 - 60                     |
| 3/4                | 60 - 90                     |
| 1                  | 70 - 100                    |
| 1¼                 | 90 - 120                    |

3. The manufacturer shall confirm and document the torque required for a certain installation when requested by the Architect/Engineer. The above torque loads may be applied with torque measuring or indicating wrenches, or they may be applied using regular socket wrenches and checked with torque wrenches.
  4. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation practice will not be permitted. Anti-seize lubricant shall be used with stainless steel bolts. All bolts shall be of the style, length and diameter called for by the manufacturer for the particular application. Nuts shall seat fully and be fully threaded.
  5. Also refer to Section 331200 - Corrosion Protection of Plastic Pipe Systems.
- E. Pipe Deflection: Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane to avoid obstructions where long-radius curves are permitted.
1. The amount of deflection allowed shall not exceed that required for satisfactory jointing and shall not exceed the applicable material and joint specifications of the latest edition of AWWA C600 and AWWA M233, nor shall they exceed the recommendations of the pipe manufacturer whichever is more stringent.
  2. Bending of smaller diameter pipe is allowed, if allowed by the manufacturer and AWWA M23, up to the more stringent limits of the two.
  3. Care must be taken to not deflect or bend the pipe past the allowable amount. Additional excavation shall be made when necessary to reduce vertical joint deflections to acceptable levels, and to avoid high points in the line, other than those shown in the construction plans.
  4. When rubber gasketed pipe is lain on a curve, the pipe shall be joined in a straight alignment and then deflected to the curved alignment. Trenches shall be made wide on curves for this purpose.
  5. All high points are to occur at air release valves.
- F. Rubber Gasketed Joints: Jointing of pipe made with a rubber gasket joint shall be made as recommended by the manufacturer.
1. The rubber gasket and gasket seats inside the bell shall be wiped clean with a cloth. A thin film of lubricant, furnished with the pipe, shall be applied to the inside surface of the gasket, per manufacturer's requirements.

2. The plain end of the adjoining pipe shall be wiped clean and inserted on a straight line into the bell a sufficient distance to make contact with the gasket.
  3. The plain end shall then be forced "home" by the use of a crowbar, fork tool or jack assembly. Care must be taken to not insert the pipe past the home line.
  4. The Contractor shall not over-stab the pipe joint by inserting the spigot past the "home line" marked on the spigot end. Hand stabbing or stabbing using manual lever-type devices are preferable for making joint connections. All over-stabbed joints shall be removed and reinstalled. If power equipment is used to perform the pipe stabbing operation and results in the movement of the pipe into which the spigot end is being inserted, the Contractor shall expose a minimum of three previously installed joints to allow the inspector to verify if previous joints are past the "home line".
  5. If Contractor's method of installation results in previously installed pipe joints moving such that the "home line" is not visible, then the Contractor shall modify his installation method to result in an acceptable installation.
- G. Testing and Disinfection: Pipelines and appurtenances shall be tested and disinfected as specified in Section 331210 - Disinfecting Water Piping Systems.
- H. Separation with Sewers: Water mains and water service lines shall be installed to provide at least a 10-foot horizontal separation from any existing sanitary or storm sewer. This distance shall be measured from edge-of-pipe to edge-of-pipe. These requirements include water service lines.
1. Water and sewer service lines may be installed closer than 10 horizontal feet and in the same trench if the sewer service line is constructed using Schedule 40 PVC with glued joints.
  2. At crossings, a minimum vertical distance of 18-inches from edge-of-pipe to edge-of-pipe shall be maintained between the water and the sewer pipes. This shall be the case when the water main is either above or below the sewer.
    - a. At crossings, one full length of water main shall be located so both joints are as far as possible from the sewer. Joints in sewers at crossings shall be located at least 6 feet from water mains.
    - b. At all crossings, pipe and backfill shall be properly installed to support the pipes.
      - 1) When required, flowable fill (see Section 033100 - Site Concrete Work for mix design) is to be used at the crossing to fully support both pipes. The material is to be tamped and rodded to fill all voids adjacent to and below both pipes and to compact the fill material.
    - c. When the required separations between water lines and sewer cannot be maintained, the sewer and water line shall be placed in separate conduit pipe or a cement treated saddle.
- I. Thrust Blocking or Joint Restraints:
1. Thrust blocking or joint restraints shall be installed at all vertical and horizontal fittings such as plugs, caps, tees, crosses, valves and bends greater than, or equal to 11-1/4 degrees, per the construction plans.
  2. All concrete thrust blocks shall be formed and poured against undisturbed earth.
  3. After the thrust block is in place, all pipe joints and bolts shall still be accessible.
  4. The concrete thrust blocks should be allowed to cure before hydrostatically testing the pipe. The concrete shall attain at least 80 percent of its design strength as documented by compressive strength test results, or allow seven days to elapse if compressive strength testing is not done.
  5. The heights of the thrust blocks should not exceed one-half of the depth from the ground surface elevation to the bottom of the thrust block.
  6. Bagged, pre-blended concrete material (such as Sakcrete or Quikrete) is not allowed for use in constructing thrust blocks unless otherwise approved by the City of Gillette.

- J. Warning Tape: Non-detectable Warning Tape shall be buried 24" above the pipe, unless specified otherwise.
- K. Tracer Wire: Tracer wire shall be installed above all pipes as shown in the construction plans.
1. The tracer wire shall be insulated and brought to the surface in tracer wire access boxes at all hydrants.
  2. The continuing wire shall also have a lead which begins at the surface and follows hydrant to the underground pipe.
  3. Tracer wire shall be attached to top of pipe with polyethylene tape at 10-foot maximum intervals.
  4. Tracer wire shall be tested prior to final acceptance of the water line in accordance with Section 331200 - Corrosion Protection of Plastic Pipe Systems, and approved by the Architect/Engineer.
  5. The system of tracer wire shall be continuous. Splicing, or other means used, to provide a continuous wire, along with leads for testing, shall be as specified in Section 331200 - Corrosion Protection of Plastic Pipe Systems, or as approved by the Architect/Engineer.
  6. Tracer wire for service lines shall not connect to the main line tracer wire.
- L. Polyethylene encasement shall be installed as per AWWA C105/A21.5 on all fire hydrants, ductile iron pipe and fittings, and curb stop boxes. Overlaps shall be secured to top of pipe by the use of adhesive tape, plastic string, or other material capable of holding the polyethylene encasement in place until backfilling operations are complete.
- M. Temporary Water: Contractor shall install a temporary water service main and temporary individual water service lines to each affected resident or business during water main and service line replacement.
1. Contractor shall provide a plan for installation, operation, and maintenance of the temporary system. Contractor shall coordinate with the Architect/Engineer prior to transitioning to the temporary water system. A minimum of 1 week notice shall be provided to the Architect/Engineer.
  2. The temporary water system shall be installed in accordance with all applicable water system specifications of this Section.
  3. Contractor shall also provide an executed "Temporary Water Service Line Alteration Sheet" within 24 hours of connection to temporary water. The temporary system may be supplied by direct connection to the City's water distribution system at the ends of construction, and may utilize connection points at existing fire hydrants or as approved by the City and/or Architect/Engineer.
  4. Individual water service lines shall be complete with isolation valves, metering, and backflow prevention. Connection of temporary service shall be identified in the field after consultation with the property owners.
  5. The Contractor is ultimately responsible that each required service is installed. Contractor shall be responsible for cleaning debris from water meters, filters, etc. if problems arise. The temporary water service system shall not have any leaks. If leaks arise, they shall be immediately remedied. The Architect/Engineer shall notify the Contractor of any leaks found.
  6. If the temporary water service system will be in operation during seasonal periods during which it may be subject to freezing, Contractor will provide a plan to prevent freezing. Contractor shall be responsible to prevent freezing and promptly repair damage and icing at no additional cost.
  7. Any temporary or permanent plugging of existing lines in order to install temporary water systems, or to otherwise allow for construction of the water system, shall also be considered incidental to the construction and not paid for separately.

8. The Contractor must submit plans for any water shut-offs required to install the temporary or permanent water system. A minimum of one week must be provided to the City prior to any water shut-off, and a minimum of 48 hours' notice must be provided to any affected customers. No water may be shut off for more than four (4) hours, except water may be shut off during non-business hours for affected businesses.

N. Live Tapping on Existing Mains

1. The Contractor shall perform all live taps on existing water mains for connections 2 inches and smaller. The Contractor shall perform all excavation prior to the live tapping, furnish the corporation stop and service saddle to the City, and place and compact all backfill.
2. For live taps performed by either the City or the Contractor, the Contractor shall be responsible for notifying the City and the Architect/Engineer at least 48 hours in advance of the time that the live tap will be made. The Contractor shall also be responsible for scheduling the live taps if it is to be performed by the City, and for coordinating all activities pertaining to the live tap.
3. Tapping directly into the barrel of PVC pipe will be done using service clamps.

O. Connections to Existing Mains

1. All connection to water mains in use shall be made by the Contractor. Contractor shall furnish all materials as required and perform all excavations to ensure gradual transition between the new and existing water main. Contractor shall perform all necessary backfilling.
2. Where the connection of new work to old requires interruption of service and notification of customers affected, the superintendent of the Utility, Architect/Engineer, and Contractor shall mutually agree upon a date for connections which allow ample time to assemble labor and materials, and to notify all customers affected.

END OF SECTION 331100

## SECTION 331110 - WATER VALVES AND VALVE BOXES

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered includes the furnishing and installation of exterior mainline valves and appurtenances.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312316.13 - Trenching
- C. Section 330200 - Underground Utilities
- D. Section 331100 - Water Main
- E. Section 331120 - Fire Hydrants
- F. Section 331200 - Corrosion Protection of Plastic Pipe Systems
- G. Section 331210 - Disinfecting Water Piping Systems

#### 1.03 REFERENCE STANDARDS

- A. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
- B. AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
- C. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

#### 1.04 RESPONSIBILITY FOR MATERIALS:

- A. The Contractor shall be responsible for all such material furnished by them and shall replace, at their own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the work, or during the one-year correction period.
- B. The Contractor shall be responsible for the safe storage of materials furnished by them, or to them, and accepted by them and intended for the Work.
- C. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

#### 1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.

### PART 2 - PRODUCTS

#### 2.01 BURIED VALVES AND ACCESSORIES:

- A. Gate Valves: All buried valves 12-inch and smaller shall be resilient seat gate valves, unless shown otherwise in the construction plans.
1. Gate valves shall be the resilient seat or resilient wedge type, being American AVK Series 25, American Flow Control Series 2500, Mueller A-2360, or Architect/Engineer approved equal. Matco 4-inch valves are disallowed.
  2. The gate valves shall meet all provisions and requirements of the latest editions of the AWWA C509 or AWWA C515.
  3. Valves shall have iron bodies and be equipped with nonrising bronze stems and double "O" ring seals.
  4. The wedge or gate shall be completely encapsulated in rubber or other acceptable material. All bolts, nuts, and washers shall be series 304 or 316 stainless steel.
  5. Iron and steel valves shall be coated inside and out per Section 331200 - Corrosion Protection of Plastic Pipe Systems. A manufacturing affidavit or certification shall be provided which states that coatings furnished are fusion bonded epoxy complying with the appropriate standards referenced in Section 331200 - Corrosion Protection of Plastic Pipe Systems, and that all required inspections and tests, and surface preparation called for by Section 331200 - Corrosion Protection of Plastic Pipe Systems have been completed. The coating thickness shall be as specified in Section 331200 - Corrosion Protection of Plastic Pipe Systems.
  6. Valves shall be designed for a minimum working pressure of 250 psi.
  7. Wrench nuts shall be 2 inches square at the base, 1-15/16 inches square at the top, and shall be 1-3/4 inches high.
  8. Valve operating nut shall be bronze, stainless steel or fusion bonded epoxy coated. The direction of opening shall be counter-clockwise, and the word "OPEN" shall, in 1/2 inch or larger letters, be cast on the wrench nut to indicate clearly the direction to turn the wrench nut when opening the gate valve.
  9. Valve ends are to be restrained. Valves may either be mechanical joint, restrained with EBAA Iron series 2000 restraints, or approved equal; or be push on and restrained with EBAA Iron series 1600, or 15/19PF00 (using the lugs on the valve), or approved equal.
  10. Valves shall be flanged, if specifically called out in the construction plans.
  11. Valves are to be placed on a concrete support block(s).
  12. Valves on branch runs of a swivel tee are to be bolted to the swivel tee.
- B. Valve Boxes: Valve boxes shall be cast iron, adjustable, screw type, round base, 5-1/4 inch stem opening with necessary extensions to adjust the box height from the valve to the ground level, or future finished street level.
1. Lids for valve boxes shall be cast iron and shall have the word "WATER" clearly cast on the top surface of the lid.
  2. Boxes shall be painted in accordance with the provisions and requirements set forth in AWWA C550, latest edition. Valve boxes shall be Tyler 6850, or Architect/Engineer approved equal.
    - a. Boxes shall be double wrapped in an 8-mil thick sheet of polyethylene encasement.
    - b. Valve boxes of the length required to reach the ground surface, while maintaining a 6 inch overlap in height adjustment, shall be provided. If the top of the operating nut is more than 8 feet from the ground surface, an extension shall be provided. The nut on the extension shall be centered in the box and attached to the operating nut on the valve.
    - c. If the top of the operating nut is more than 8 feet from the ground surface, an extension shall be provided. The nut on the extension shall be centered in the box and attached to the operating nut on the valve.
    - d. A valve box alignment tool shall be used to check to make sure that the valve nut is centered, and that the valve box is plumb, prior to any installation of pavement surfacing.

- C. Valve Box Adaptors: All valve boxes shall be installed plumb and centered above the valve using a Valve Box Adaptor II as manufactured by Adaptor Inc., or an Architect/Engineer approved equal.
- D. Tapping Sleeve Valves: Valves attached to tapping sleeves shall be iron body, resilient wedge tapping valves with flange by mechanical joint ends. They shall be specifically designed for this purpose.
  - 1. Valves shall be Mueller A-2360-16, or approved equal, in sizes as shown in the plans.
  - 2. Operating nut shall be 2 inches square at the base, 1-15/16 inches at the top, and shall be 1-3/4 inches high.
  - 3. Valve operating nut shall be bronze, stainless steel or fusion bonded epoxy coated. The direction of the opening shall be counterclockwise, and the word "OPEN" shall, in 2-inch or larger letters, be cast into the wrench nut to indicate clearly the direction to turn the wrench nut when opening the valve.
  - 4. The stuffing box shall be O-ring sealed.
  - 5. Valves should be designed for a working pressure of 250 psi. Valves shall be Mueller A-2360-16, or approved equal in sizes as shown in the Plans.
  - 6. Iron and steel valves shall be coated inside and out per Section 331200 - Corrosion Protection of Plastic Pipe Systems. A manufacturing affidavit or certification shall be provided which states that coatings furnished are fusion bonded epoxy complying with the appropriate standards referenced in Section 331200 - Corrosion Protection of Plastic Pipe Systems, and that all required inspections and tests, and surface preparation called for by Section 331200 have been completed. The coating thickness shall be as specified in Section 331200 - Corrosion Protection of Plastic Pipe Systems.
  - 7. All bolts, nuts and washers shall be series 300 stainless steel.
- E. Tie Rods: Tie rods, when called for in the construction plans, shall be 3/4 inch diameter. Tie rods shall be series 300 stainless steel or epoxy coated rebar.
- F. Restraints: Restraints on valve ends or adjacent joints of pipe or fittings, shall be EBAA Iron, or approved equal, as called out in the appropriate specification.
  - 1. All metal in the restraint shall be stainless steel or coated as noted below.
  - 2. T- bolts and gland bolts shall be stainless steel or coated with 8 mils of fusion bonded epoxy.
  - 3. The installed device shall have a pressure rating equal to that of the pipe.
  - 4. Foster Adaptors, or approved equal, shall be used to restrain valves and/or fittings in locations where close-coupled mechanical joint connections are required.
- G. Flange Adaptor with Gap: If called for in the construction plans, a flange adaptor shall be used which provides a gap for future disassembly. This shall be an EBAA Iron 2100, or approved equal.
- H. Coatings: The coating on mechanical restraints shall be electrostatically applied polyester, 4 mils minimum, following surface preparation of a minimum of an iron phosphate bath, rinse and heat drying, or approved equal.
  - 1. The coating shall be EBAA-Iron Mega-Bond, or approved equal.
  - 2. Wedge assemblies may be Xylan fluoropolymer coated, 2 coats minimum.

## 2.02 CONCRETE SUPPORT BLOCKS:

- A. Concrete shall be Class B concrete or as specified in the plans.

## 2.03 MARKER POSTS:



- A. Markers (if called for in the Plans) shall be constructed of a composite polyethylene material and be 3-3/4 inch wide and 5-1/2 feet in length. The markers shall be colored blue with a white decal indicating a water valve. Lettering shall be blue. Markers shall be 90 Composite Utility Marker or an approved equal. Markers shall be labeled as per the Standard Details, or as shown in the Plans. Letters shall not fade for a minimum of five years.
  - 1. The markers shall be colored blue with a white decal indicating a water valve. Lettering shall be blue.
  - 2. Markers shall be Carsonite CRM375 Composite Utility Marker, or an approved equal.
  - 3. Markers shall be labeled as per the City's Standard Details, or as shown in the construction plans.
  - 4. Letters shall not fade for a minimum of five years.
- B. All valve boxes on transmission mains that are outside of a roadway shall be marked with a Utility Marker.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION OF VALVES:

- A. Valves: Valves shall be installed as near as possible in the positions indicated in the construction plans.
  - 1. When valves are located in conjunction of a tee or cross, the number of valves installed shall be one less than the number of legs extending from the tee or cross.
  - 2. All valves shall be carefully erected and supported in their respective positions free from all distortion and strain of appurtenances during handling and installation.
  - 3. All materials shall be carefully inspected for defects in workmanship and materials, all debris and foreign material shall be cleaned out of valve openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness.
  - 4. Valves shall be set plumb and supported adequately in accordance with the manufacturer's instructions.
  - 5. Valves which do not operate easily or are otherwise defective shall be repaired or replaced at the Contractor's expense.
- B. Valve location: All valves shall be placed within 2 feet of the tee or cross (measured from the closest flange to flange), unless otherwise directed by the Architect/Engineer.

#### 3.02 INSTALLATION OF VALVE BOXES:

- A. Valve boxes shall be installed with the use of an Adaptor Inc. Valve Box Adaptor II, or approved equal, to ensure installation directly over the valve operating wrench nut, in plumb position, and supported adequately.
  - 1. Care shall be taken during backfilling to ensure that the valve box remains in a vertical position and that no dirt, rocks, or debris are dumped into the valve box.
  - 2. In paved streets, the top of the valve box shall be brought to within 1/4 inch of the finished street grade as approved by the Architect/Engineer.
  - 3. In gravel or dirt roads, the top of the valve box shall be 6 inches below grade. The base of the valve box must not touch the valve.
  - 4. A rubber valve box adaptor may be used between the box and valve.
  - 5. When the valve box is in place, it must be capable of allowing the operator key to be placed on the valve nut with no difficulty. If the valve nut is not operable due to improper installation of the valve box, the box shall be reinstalled at the Contractor's expense.

#### 3.03 TIE ROD ASSEMBLIES:

- A. Where noted in the plans, or these specifications, the valves shall be tied back to the tee or fitting from which it is installed. The tie rod assemblies shall be of stainless steel. They shall be of the number required to securely anchor the valve to the water main, or as shown in the plans.

#### 3.04 THRUST/SUPPORT BLOCKS:

- A. Concrete shall be made Class B (4,000 psi) concrete. Refer to construction plans for block dimensions and placement requirements.
- B. For valves that are 12 inches, or less, a 6 inch thick by 18 inch length by 18 inch wide precast concrete support block, made with a minimum 4,000 psi concrete, shall be placed under the valve.
- C. Washed gravel shall be placed under all support blocks with a minimum depth of 4 inches and shall be at a minimum the same length and width of the support block used.
- D. Encasement of any valve in concrete is unacceptable and shall be removed and replaced immediately.

#### 3.05 VALVE RESTRAINTS:

- A. All valves shall be restrained per Part 2 of this Section.
  - 1. Joints near the valve shall also be restrained as determined by the Architect/Engineer to satisfy restrained length calculations based on the circumstances of the particular installation.
  - 2. The Architect/Engineer shall determine and have available a restrained joint plan for the Project.
  - 3. As a minimum, the joint on any fitting or bend adjacent to the valve within one pipe length of the valve shall be restrained in the same manner as the valve, and there shall be no joints between the valve and the fitting. This is a minimum and in no way states that this alone is a sufficient restrained joint system for the particular installation.

END OF SECTION 331110

## SECTION 331120 - FIRE HYDRANTS

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered includes the furnishing and installation of fire hydrant assemblies.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312316.13 - Trenching
- C. Section 330200 - Underground Utilities
- D. Section 331100 - Water Main
- E. Section 331110 - Water Valves and Valve Boxes
- F. Section 331200 - Corrosion Protection of Plastic Pipe Systems
- G. Section 331210 - Disinfecting Water Piping Systems

#### 1.03 REFERENCE STANDARDS

- A. AWWA C502 - Dry-Barrel Fire Hydrants.

#### 1.04 RESPONSIBILITY FOR MATERIAL:

- A. The Contractor shall be responsible for all such material furnished by them and shall replace, at their own expense, all such material found defective in manufacturing or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work or during the guarantee period.
- B. The Contractor shall be responsible for the safe storage of material furnished by them, or to them, and accepted by them and intended for the Work, until it is incorporated in the completed Project. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

#### 1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.

### PART 2 - PRODUCTS

#### 2.01 FIRE HYDRANT:

- A. Fire hydrants shall be Mueller Super Centurion 250 (A-423-mechanical joint), American AVK 2780 (mechanical joint), American Flow Control Waterous Pacer (WB-67-250-Mechanical joint) or Architect/Engineer approved equal and shall conform to AWWA Standard for Dry-Barrel Fire Hydrants, AWWA C502.
- B. The hydrants shall have:

1. 5 inch minimum main valve opening with one 4-1/2 inch pumper connection and two 2-1/2 inch hose connections, and an auxiliary gate valve and valve box of the size required for the inlet pipe.
  2. Hose and pumper nozzle threads shall be in conformity with ASA Specifications B26 for National Standard Fire Hose Coupling Screw Thread.
  3. Operation nut shall be National Standard 1-1/2 inch pentagon, made of bronze, and shall open counter-clockwise and shall have an arrow and the word "OPEN" cast in relief on the top of the hydrant to designate the direction of opening.
  4. A minimum 6 foot bury and be equipped with breakaway safety flanges. Some hydrants may require deeper bury. Refer to the construction plans and field verify hydrant length before ordering.
- C. Hydrants shall be compression type with safety flange and safety stem coupling above the ground line so that they can be repaired without shutting off the water.
- D. Hydrants shall be of the Dry Top Design with two or more O-rings sealing the water from the operating mechanism.
1. The operating mechanism shall be automatically lubricated from a sealed, self-contained lubricating reservoir.
- E. The portion of the hydrant above the ground line shall be painted with red enamel.
1. All chipped or damaged paint shall be repaired to the satisfaction of the Architect/Engineer.
- F. All bolts, nuts and washers in the hydrant shall be Series 316 or 304 stainless steel.
- G. The hydrant shoe and barrel shall be coated per 331200 - Corrosion Protection of Plastic Pipe Systems.
- H. The hydrant shall be equipped with a weep hole to allow for positive drainage of the hydrant after use, unless otherwise noted in the plans. For instances where weep holes cannot be used, a plug provided by the hydrant manufacturer shall be inserted in the weep hole.
- I. Hydrants shall be furnished for the riser heights as shown in the construction plans.
- 2.02 OTHER MATERIALS:
- A. Fire Hydrant Pipe: The pipe portion of the fire hydrant assembly shall conform to Section 331100 - Water Main in material and workmanship.
- B. Fire Hydrant Valve: The valves in the fire hydrant assembly shall conform to Section 331110 - Water Valves and Valve Boxes, except they shall be restrained by bolting them to the swivel tee.
1. A restrained joint per Section 331100 - Water Main on the opposite side shall be provided, if required by the construction plans.
  2. If a swivel tee is not used for a reason approved by the Architect/Engineer, the upstream side of the valve shall be restrained by a means approved by the Architect/Engineer.
- C. Joint Bond Wires and Anode: See Section 331200 - Corrosion Protection of Plastic Pipe Systems
- D. Tie Rods: Tie rods where required shall be 3/4 inch diameter. Tie rods shall be series 300 stainless steel.

- E. Thrust / Support Blocks: Concrete thrust blocking and support pad shall be installed on all hydrants.
  - 1. Concrete shall be Class B (4,000 psi) concrete.
  - 2. All sizing of thrust blocks and support pad/blocks shall be as specified in the plans.
  - 3. All thrust blocks are to be formed and poured against undisturbed soil.
- F. Swivel Tee: Mainline tees shall be Class 250 and be in accordance with all of Section 331100 - Water Main with the exception that they shall be mechanical joint or push-on by swivel.
  - 1. If swivel tees are not available in the main line pipe size, use a mechanical joint tee with restrained joints per 331100 - Water Main, as approved by the Architect/Engineer.
- G. Guard Posts: A set of guard posts shall be provided where designated on the plans, or as directed by the Architect/Engineer.
  - 1. Generally guard posts shall be provided at all hydrant locations where not behind a curb section, unless specifically deleted by the Architect/Engineer.
  - 2. Guard posts shall be 6 feet in length and be composed of 6 inch diameter Schedule 40 steel pipe filled with concrete and painted reflective yellow with corrosion protective paint.
  - 3. The post shall be embedded 3 feet and encased in a 10 inch diameter Class B (4,000 psi) concrete base.

## PART 3 - EXECUTION

### 3.01 GENERAL:

- A. The fire hydrants and valves shall be installed as shown in the plans. The final location of the hydrant shall be determined in the field. The Architect/Engineer and/or City shall approve the staked location of the hydrant before it is installed.

### 3.02 FIRE HYDRANT INSTALLATION:

- A. The fire hydrant and valve shall be installed in a plumb position with the pumper nozzle facing the street, or as directed by the Architect/Engineer.
- B. Final hydrant location, elevation, and direction of pumper nozzle shall be approved by the Architect/Engineer and/or City.
- C. The hydrants shall be installed at such an elevation that the bury line is at the same elevation as the finished grade or rear face of curb, whichever is higher.
- D. Drainage shall be provided at the base of the hydrant by placing clean washed gravel around the concrete block and base of the hydrant. Sufficient gravel shall be used to provide a minimum of 1 foot on all sides of the base of the elbow to a point at least 6 inches above the drain opening. Gravel is not required if weepholes are not allowed due to groundwater elevation.
- E. A thrust block and support block of dimensions required shall be poured at the base of the hydrant as shown in the construction plans.

### 3.03 HYDRANT PIPE AND VALVE INSTALLATION:

- A. Installation of hydrant pipe shall be in conformance with Section 331100 - Water Main while valves shall be in conformance with Section 331110 - Water Valves and Valve Boxes.

3.04 CATHODIC PROTECTION:

- A. Joint bonds and anodes are to be provided in accordance with Section 331200 - Corrosion Protection of Plastic Pipe Systems and the plans. The fire hydrant shall be bonded, polyethylene encases, and cathodically protected with 17 lb galvanic anode or 6 ounce Mars Company zinc anode caps placed on all tee bolts may be used as a substitute for an anode, if approved by the Architect/Engineer.

3.05 SALVAGE AND REMOVAL OF EXISTING FIRE HYDRANTS:

- A. Existing fire hydrants as shown in the plans shall be removed, including the hydrant, barrel and shoe. If the water line is to remain live, a plug and thrust block shall be installed.
- B. Some existing fire hydrants to be removed may not be equipped with an isolation valve. The Contractor shall be aware of this prior to any removal so as to comply with shut down durations allowed.
- C. Removed hydrants shall be made available to the City for salvage. If the City does not want the hydrant, the Contractor shall dispose of the removed materials off the site.
- D. Where called for in the construction plans, salvaged hydrants are to be relocated along with isolation valve and installed as shown in the plans. The final location of the hydrant shall be determined in the field. The Architect/Engineer and/or City shall approve the staked location of the hydrant before it is installed.

**END OF SECTION 331120**

## SECTION 331150 - WATER SERVICE

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work includes furnishing and installing service clamps, corporation stops, service line piping, curb stops, and boxes.
- B. This section also includes meter pits and components, and water quality sampling stations.
- C. Unless obtained by the Architect/Engineer, a permit for the service line work shall be obtained from the City Utility Department. All service line work shall comply with City Codes and the currently adopted Plumbing Code. Inspection by the City shall be arranged for when required.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications
- B. Section 312316.13 - Trenching
- C. Section 330200 - Underground Utilities
- D. Section 331100 - Water Main
- E. Section 331200 - Corrosion Protection of Plastic Pipe Systems
- F. Section 331210 - Disinfecting Water Piping Systems
- G. Section 340100 - Temporary Traffic Control

#### 1.03 REFERENCE STANDARDS

- A. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- B. AWWA C800 - Underground Service Line Valves and Fittings.
- C. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service.
- D. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

#### 1.04 RESPONSIBILITY FOR MATERIALS:

- A. The Contractor shall be responsible for all such material furnished by them and shall replace, at their own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work, or during the one year correction period.
- B. The Contractor shall verify that all various service line components supplied from the various sources have compatible threads, couplings, and types of end connections, and that the end product is a complete, watertight unit that functions as intended by this design.

- C. The Contractor shall be responsible for the safe storage of material furnished by them or to them and accepted by them and intended for the work. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

#### 1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.

#### 1.06 BACKFLOW PREVENTION

- A. All services are to be equipped with appropriate backflow prevention device per Wyoming Department of Environmental Quality requirements (Chapter 12 of *Water Quality Rules and Regulations*).
- B. If specific backflow preventers, location and method of installation are not included in the construction documents, materials and work shall comply with City and State requirements relating to backflow prevention.
  - 1. The Contractor shall provide a submittal for the proposed backflow prevention measures. This shall be approved by the City prior to installation.

### PART 2 - PRODUCTS

#### 2.01 PIPE:

- A. Copper Water Service Line: Copper pipe used for water service lines shall be Type K, soft temper, meeting the requirements and provisions of AWWA C800.
  - 1. Corrosion protection shall be in accordance with Section 331200 - Corrosion Protection of Plastic Pipe Systems.
- B. HDPE Water Service Line: HDPE shall be PE 3408 high-density polyethylene pipe (HDPE) meeting the requirements of ASTM D3350 cell classification PE 345434C.
  - 1. HDPE shall be manufactured in accordance with NSF Standard #14, and meet the requirements of AWWA C901.
  - 2. PE pipe shall have a minimum pressure rating of 200 psi with a DR or SDR of 9.
  - 3. PE pipe shall be copper tube size.
  - 4. Joints: The polyethylene pipe shall be of continuous construction in rolls of the manufacturer's standard length. Pipe ends shall be cut square and joined in accordance with the manufacturer's recommendations.
  - 5. The water service line shall be a continuous run of pipe from the water main to the curb stop, no joints shall be allowed. The water service line shall be a continuous run of pipe from the curb stop to the meter, no joints shall be allowed.
    - a. Joints shall be butt fused. The procedures of the pipe manufacturer and the fusion machine manufacturer shall be followed. The wall thickness at the joint shall have the same DR as the pipe.
  - 6. Fittings: For connecting polyethylene pipe, sections shall be brass, rubber insert, or compression type fittings recommended by the manufacturer.
    - a. Two stainless steel clamps are required for insert type fittings. Flared fittings will not be allowed.
    - b. All fittings shall be tape coated per Section 331200 - Corrosion Protection of Plastic Pipe Systems.
- C. Connections: Care must be taken to assure connections to corp. stops, curb stops, meter pits, transitions to other pipe materials, etc. are properly made.



1. All connections shall be water tight, and shall not easily pull apart.
  2. All connections shall be per manufacturer's design for the specific pipe type.
  3. When connecting to an existing metallic water service line, Contractor shall install a 17-lb. magnesium anode on the service line as detailed in Section 331200 - Corrosion Protection of Plastic Pipe Systems.
- D. Tracer Wire: Where non-metallic pipe is used, tracer wire conforming to Section 312316.13 - Trenching shall be installed with each service line beginning at the main, and brought up by the curb box (outside of box by lid).
1. A minimum of 6 inches of excess tracer wire is to be coiled up under the lid and shall not be left exposed to the elements.

## 2.02 STOPS AND BOXES:

- A. Corporation Stops: Corporation stops shall be brass corporation stops having a compression connection outlet with gasket, and inlet end with CC thread to suit tapping requirements.
1. Corporation stops shall comply with AWWA C800.
  2. Copper tubing services shall use a Mueller H-15008 or H-15013, or approved equal.
  3. HDPE pipe services shall use a Ford FB 1001, or approved equal.
    - a. An appropriate stainless steel insert stiffener shall be used with the HDPE pipe.
- B. Service Saddles: Shall be used on all PVC water mains. Saddles shall be stainless steel or brass with an O-ring or Buna-N gasketed seal.
1. All stainless steel service saddles bolts and nuts shall be 304 stainless steel.
  2. Brass service saddles shall have brass bolts with brass alloy nuts.
    - a. Nuts shall be coated to prevent galling.
    - b. Washers shall be stainless steel, Nylatron, or approved equal.
    - c. Clamps shall be a Ford FS 303, Romac 306, or approved equal.
- C. Curb Stops: Curb stops for 1-inch to 2-inch copper water service shall comply with AWWA C800.
1. Copper tubing services shall use a Mueller Series 35000, or approved equal, curb stop having electrically insulated ball type compression connections.
  2. HDPE pipe services shall use a Mueller H-15209 curb stop, or approved equal.
- D. Curb Boxes: Curb boxes for water services shall be cast iron, arch pattern base with a stationary 4 foot rod.
1. Curb boxes for 1-inch curb stops shall be Mueller Type H10314, or approved equal.
  2. Curb boxes for curb stops greater than 1-inch shall be Mueller H10386, or approved equal.
  3. All curb boxes shall be within 3 inches of the middle of the adjustment when its top is set at finished ground elevation.
  4. Curb boxes shall include a 300 stainless steel stationary 4 foot rod and pin that are sized appropriately to the size of the curb stop. The stationary rod shall be bolted to the curb-stop. The rod length shall be 4 feet in length.
  5. All curb boxes shall be double wrapped in 8-mil polyethylene encasement.
- E. Curb Box Sleeve: In concrete or asphalt pavement, curb box sleeves shall be installed around the top of the curb box.
1. Curb box sleeves shall be Mueller H-10342, or approved equal.
- F. Insulating Unions: Insulating unions are only required if a new curb stop is not installed, or if a 1-1/2 or 2 inch curb stop is used and they are not available in the insulating style.

1. Curb stops are to be insulated when available.
2. Refer to Section 331200 - Corrosion Protection of Plastic Pipe Systems for further description of insulating unions.

## 2.03 ANODES:

- A. Anodes: Anodes shall be in accordance with Section 331200 - Corrosion Protection of Plastic Pipe Systems on copper lines.
- B. Ground Clamps: Clamps shall be bronze. Clamps, nuts, and bolts shall be in accordance with Section 331200 - Corrosion Protection of Plastic Pipe Systems.

## 2.04 METERS AND METER PITS:

- A. Meter Pits: Meter pits shall be Mueller Thermal-Coil Meter Box, or an approved equal.
  1. Meter pits shall have an inlet angle ball valve, outlet angle dual check valve, and a straight ball valve on the outlet.
    - a. Angle ball valve shall be a Mueller B24265, or approved equal.
    - b. Angle dual check valve shall be a Mueller H-14244-A, or approved equal.
    - c. Straight ball valve shall be a Mueller B20200, or approved equal.
  2. The meter size shall be 5/8" x 3/4", unless called out in the construction plans, and approved by the City.
    - a. Type 1 meter pit contains only a meter.
    - b. Type II meter pits contain a meter and individual PRV in series mounted in a dual yoke.
  3. Inlet and outlet connections shall be threaded brass. These connections shall be fastened securely to the pit wall.
  4. The meter pits shall be 18 inches in diameter with a 0.30-inch minimum PVC wall, and a minimum height of 72 inches.
    - a. A larger pit shall be provided with larger meters.
  5. Coiled tubing shall be 3/4-inch polybutylene, complying with ASTM D2666. Tubing shall be Class 250. Tubing shall be long enough to easily allow the meter to be pulled up to the ground surface.
  6. The meter and PRV shall be mounted on a 1/2 inch thick ABS plastic platform. Ridges to hold the platform shall be located at the top of the pit and at a depth of 48 to 64 inches.
  7. A brass U-bar shall run from the outlet side of the PRV to the inlet side of the meter.
  8. A 4 inch thick polypropylene insulation pad shall fit snugly into the pit. This pad shall not absorb water.
  9. A looped 1/4" nylon rope handle shall be provided on the insulation pad.
  10. The lid shall be cast iron and be securely fastened in place with a pentagon nut.
    - a. The lid shall be designed to with a hole in the lid to accommodate the Mi.Net® node read system.
  11. The above specifications for the structural aspects of meter pit are a minimum. If additional wall thickness or other structural enhancements are needed to keep the pit round after backfill and allow for the easy removal and replacement of the lid and internal components in the pit, they shall be provided.
    - a. Pit lids and locking mechanisms shall operate easily and be easily removed and replaced.
    - b. Any ridges and internal lips in the pit that are attached to the wall shall be firmly and permanently attached to the wall with corrosion resistant fasteners.
    - c. The fasteners shall remain securely in-place as lids and internal components in the pit are removed and replaced.
- B. Meters: All meters shall be installed by the City.

- C. Individual Pressure Reducing Valves: Individual PRV's for meter pits or mounted with the meter in a building, shall have cast bronze body; integral stainless steel strainer and replaceable seat module. Adjustable outlet pressure shall conform to IPC standards. The PRV shall be set to an outlet pressure of 75 psi unless otherwise indicated by the Architect/Engineer (standard outlet pressure factory setting is 50 psi).
  - 1. All springs, trim, and fasteners shall be stainless steel.
  - 2. The PRV is to be a Watts 5M3Z6-HP, or approved equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION:

- A. Corporation stops, curb stops, piping, curb boxes, meter pits, and all miscellaneous material shall be handled and installed with care to prevent damage to the pipe and fittings.
- B. Trenching, backfilling, imported bedding material, and compaction shall conform to Section 312316.13 - Trenching.
- C. All materials shall be laid on a firm, uniform foundation.
- D. A short loop in the service pipe at the corporation stop shall be provided for expansion and contraction of the service pipe.
- E. Water service lines shall be connected no closer than 2 feet from the closest main line fitting.
- F. Contractor shall be responsible for locating existing curb stops to be connected into or to be replaced, and the Architect/Engineer and/or City shall verify the location prior to connecting to the existing line.
- G. In those areas where lawns have been established within the right-of-way or easement, the Contractor shall take efforts to reduce the disturbance to these lawn areas to that area necessary for service installation only.
- H. The Contractor shall protect, restore, or replace any fence sections disturbed during service installation.
- I. The Contractor shall protect all existing curb and gutters and sidewalks and shall replace all sections damaged during construction, unless the section is shown to be removed on the plans.
- J. Areas disturbed by the construction of the water services shall be restored to match the existing conditions, unless otherwise shown on the plans.

### 3.02 PIPING

- A. Pipe installation shall comply with AWWA C901 and/or AWWA C800, as appropriate.
- B. Service pipe shall be buried 6 feet below finished ground surface, including where the service line passes under a ditch.
- C. Pipe ends shall be cut square and joined in accordance with the manufacturer's recommendations.
- D. The service pipe shall be of continuous construction in rolls of the manufacturer's standard length.
- E. The water service line shall be a continuous run of pipe from the water main to the curb stop, no joints shall be allowed.

- F. The water service line shall be a continuous run of pipe from the curb stop to the meter, no joints shall be allowed.
- G. Areas disturbed by the construction of the water services shall be restored to match the existing conditions, unless otherwise shown on the construction plans.

### 3.03 METER PITS

- A. Meter pits shall be installed on firm ground and shall be connected to the service line and installed in a plumb position.
  - 1. All meter pit lid locks shall be fully operable with an operator wrench, after installation.
  - 2. The Contractor shall notify the City and/or Architect/Engineer at least 8 hours prior to backfilling so that measurements and dimensions can be taken to locate them for future use.

### 3.04 CURB STOPS/BOXES:

- A. A curb stop shall be installed on each service line at a distance of 1 foot outside of the property line, or as shown in the plans.
- B. The curb box shall be installed plumb and centered over the operating nut of the curb stop. The curb box shall be placed so its final position allows for vertical adjustment.
  - 1. The curb box shall be constructed with a minimum 6 feet of bury.
  - 2. The curb box lid shall be marked with the word "WATER" cast into the lid.
  - 3. The curb box shall extend from the curb stop to, and not above, the finished grade.
  - 4. Curb box shall be double wrapped with polyethylene encasement.
- C. If the stop is broken on the curb stop or it can be rotated 360°, it shall be replaced by the Contractor.
- D. A 12 inch x 12 inch x 4 inch concrete pad shall be placed under curb stops.

### 3.05 PVC PIPE WRAP TAPE

- A. When approved by Architect/Engineer, HDPE service pipes and where the corp. stop, saddle, or curb stop are not otherwise protected by an anode, the corp. stop, service saddle, and, curb stop may be wrapped in PVC pipe tape with a minimum of 10 mil thickness in lieu of petrolatum tape.

### 3.06 TESTING AND STERILIZING

- A. Service lines installed that do not also provide for fire suppression shall be pressure tested and flushed in accordance with the pressure testing, flushing, and allowable leakage requirements outlined in Section 331210 - Disinfecting Water Piping Systems.
- B. Service lines installed that also provide for fire suppression shall be pressure tested and flushed in accordance with the requirements for pressure testing and flushing as stipulated by the National Fire Protection Association's NFPA 24 standard. Allowable leakage will be the same as that allowed in Section 331210 - Disinfecting Water Piping Systems.
- C. The pressure testing and flushing requirements are stated in the Contractor's Material and Test Certificate for Underground Piping form located in the City of Sheridan Standard Specifications and Details for Street and Utility Construction.

### 3.07 SURFACE RESTORATION

- A. Water services shall have the trench surfaces restored as specified in Sections 312316.13 - Trenching and 329201 - Reclamation and restored as asphalt, gravel, concrete, or unsurfaced trench restoration to match the existing conditions unless the area is shown to be resurfaced.

END OF SECTION 331150

## SECTION 331200 - CORROSION PROTECTION OF PLASTIC PIPE SYSTEMS

### PART1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. Provide coatings and cathodic protection on all buried, submerged, or immersed ferrous metal (steel, ductile iron, and cast iron) piping and fittings.
- B. Provide galvanic anodes, joint bonds, and tight bonded coatings for all ferrous metallic pipe and fittings used in conjunction with plastic pipe sections.
- C. Maintain electrical isolation of cathodic protected pipes from other unprotected metallic pipes, structures, and grounding systems. Do not connect grounding system to cathodic protected portions of metallic pipelines, provide alternate grounds.
- D. Install tracer wires.
- E. Provide coatings, insulate and cathodic protection on all buried, submerged, or immersed copper services and fittings.
- F. Provide petrolatum tape coatings for isolated copper fittings if not cathodically protected.
- G. Provide petrolatum tape coatings for restraining glands and tie rods if not already coated with a specified factory applied coating. Asphaltic coating is not a specified coating.
- H. Polyethylene case valve and curb boxes.
- I. When connecting to existing cast or ductile iron water lines, attach an anode to the existing pipe at the point of connection.
- J. Below grade Fittings and Appurtenances Coating:
  - 1. Where coating and lining specified for main pipeline is not feasible, coat and line all buried metallic (steel, ductile iron, and cast iron) valves, fittings, flexible couplings, incidental metallic piping, glands, blow-offs, and hydrants internally and externally with liquid epoxy or fusion bonded epoxy coating in accordance with AWWA C116 or AWWA C550 and this specification. Internal coatings shall be NSF approved for potable water service.
  - 2. Provide Series 300 stainless steel materials or coat all other miscellaneous buried metallic items, (tie rods, thrust restraints, tapping saddles, harnesses, etc.).
  - 3. Coat tie rods and rebar when directly exposed to soil. Provide with factory applied epoxy coating, fusion bonded epoxy coating, heat shrink sleeves, or with coating recommended by coating manufacturer for buried application and approved by Architect/Engineer for intended exposure.
  - 4. Coat above-grade piping, vent pipe, bollards, etc. exposed to atmospheric conditions with two coats of polyamide epoxy and one topcoat of polyurethane enamel or with a fusion bonded epoxy coating system. Color selected by City.

#### 1.02 RELATEDWORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312316.13 - Trenching
- C. Section 330200 - Underground Utilities

- D. Section 330500 - Manholes
- E. Section 331100 - Water Main
- F. Section 331110 - Water Valves and Valve Boxes
- G. Section 331120 - Fire Hydrants
- H. Section 331150 - Water Service

#### 1.03 GENERAL:

- A. Like items of materials provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
- B. The Contractor shall be responsible for all such material furnished by him/her and shall replace, at his/her own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work or during the one-year correction period.
- C. The Contractor shall be responsible for the safe storage of materials furnished by him/her or to him/her and accepted by him/her and intended for the Work. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

#### 1.04 REFERENCE STANDARDS:

- A. General: The latest revision of the following minimum standards shall apply to the materials and installation included in this specification, except where more stringent standards are applicable. In case of conflict, the most stringent requirements shall apply.
  - 1. American National Standards Institute (ANSI): ANSI C80.1-90, Rigid Steel Conduit-Zinc Coated.
  - 2. American Society for Testing and Materials (ASTM):
    - a. ASTM B418, Standard Specification for Cast and Wrought Galvanic Zinc Anodes.
    - b. ASTM C94/C94M, Standard Specification for Ready-Mixed Concrete.
  - 3. American Water Works Association (AWWA):
    - a. AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
    - b. AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
    - c. AWWA C216, Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
    - d. AWWA C217, Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
    - e. AWWA C550, Protective Epoxy Interior Coatings for Valves and Hydrants.
  - 4. American Wood Preservers Association (AWPA):
    - a. AWPA C2, Commodity Standards for Lumber and Timber
    - b. AWPA P5, Waterborne Preservatives
  - 5. National Association of Corrosion Engineers International (NACE),
    - a. Recommended Practice RP0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
    - b. Recommended Practice RP-02-86, The Electrical Isolation of Cathodically Protected Pipelines.
  - 6. National Electrical Manufacturers Association (NEMA):
    - a. NEMA TC 2-83, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

- b. WC 3-80, Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (R 1986).
  - c. WC 5-73, Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (R 1985).
  - d. WC 7-88, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
7. National Fire Protection Association, National Electrical Code, NFPA 70.

#### 1.05 DEFINITIONS:

- A. Cathodic Protection, (Cathodic Protect, Cathodically Protected, etc.): An electrical method of reducing or eliminating corrosion by making previous anodic areas on a structure surface, turn into a cathode by creating a dc current flow to the structure surface.
  - 1. Two common cathodic protection methods are galvanic anodes and impressed current cathodic protection systems.
    - a. A galvanic anode system consists of galvanic anode materials (usually magnesium or zinc) that naturally corrodes or sacrifices itself and does not require an outside power source.
    - b. An impressed current type system utilizes an outside power source usually a rectifier (that converts ac to dc current) and forces (impresses) current from a number of anodes (or grounded) through the environment to the structure to be protected.
- B. Electrically Continuous Pipeline: A pipeline which has a linear electrical resistance equal to, or less than, the sum of the resistance of the pipe plus the maximum allowable bond resistance for each joint as specified in this section.
- C. Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, reinforcement, casings, etc.) and the environment as defined in NACE PR0286, The Electrical Isolation of Cathodically Protected Pipelines.
- D. Ferrous or Metallic Pipe: Any pipe of fitting made of steel or iron, or pipe containing steel or iron as a principal structural material (such as steel, ductile iron, and cast iron), except reinforced concrete pipe or stainless steel.
- E. Fittings: Appurtenances to include but not be limited to valves, fittings, tees, angles, couplings, tapping saddles or sleeves, blow-offs, hydrants, including glands, etc.
- F. Fasteners: To include but not be limited to bolts, nuts, washers, tie-rods, screws, restraining devices, etc.
- G. Foreign Owned: Any buried pipe or cable not specifically owned or operated by the City.
- H. Functional and Performance Testing: Tests necessary to demonstrate that installed equipment and systems function as specified and operate in the manner intended. Functional testing is a prerequisite to performance testing for equipment and systems specified to have a performance test.
- I. Joint Bonds: A method of making the pipeline electrically continuous by connecting a wire(s) across each side of the pipe joint or fitting
- J. Lead, Lead Wire, Joint Bonds, Pipe Connecting Wires, Cable: Insulated copper conductor; the same as wire.
- K. Loose Bonded Coatings: A dielectric coating that is not bonded or physically attached to the pipe surface (polyethylene encasement).



- L. Manufacturer's Representative: Employee of manufacturer who is factory trained and knowledgeable in technical aspects of their products and systems.
- M. Petrolatum: A purified mixture of semisolid hydrocarbons obtained from petroleum jelly.
- N. Petroleum Wax: A refined mixture of solid hydrocarbons, paraffin in nature, obtained from petroleum. Provided as a refined paraffin wax or microcrystalline wax forms.
- O. Structure-to-reference electrode potential (also structure-to-reference electrode voltage): The difference in voltage (potential) between the subject metallic structure and the electrolyte in which it is buried or submerged, as measured to the standard specified reference electrode placed in contact with the electrolyte.
- P. Tight Bonded Coatings: A dielectric coating that is bonded or physically attached to the pipe surface.
- Q. PVC pipe wrap tape with a minimum of 10 mil thickness can be used in lieu of Petrolatum Tape, when approved by Architect/Engineer.

#### 1.06 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.
- B. Provide catalog cuts and other information for all products proposed for use that shows compliance of those materials with these Specifications.
  - 1. Submittals shall also include:
    - a. Installation, material, and safety requirements for thermite weld wire connections.
    - b. Quality Assurance Submittals:
      - 1) Manufacturer's Certificates of Compliance.
      - 2) Field Test Reports.
      - 3) Certificate of Compliance with independent laboratory analysis stating that galvanic anode and backfill material supplied meets the requirements of this Specification.
      - 4) Certificate of Compliance from fitting and appurtenance manufacturer and supplier that bolting, nuts, and washers were provided with stainless steel Series 300 materials as specified.

#### 1.07 QUALITY ASSURANCE

- A. Contractor's Competency: Contractor shall have a minimum of two (2) years of practical experience in the type of work called for in this specification, and shall have knowledge about local soil conditions. Contractor may be required to show proof and furnish a list of references substantiating this requirement to the satisfaction of the City.
- B. The Contractor shall provide at all times a thoroughly experienced and competent field foreman, who will be present to supervise this portion of construction on-site. This person shall be responsible for the field test reports and have the authority to represent the Contractor, and be the point of contact with the Architect/Engineer for this section of the specifications.
- C. The galvanic anode corrosion protection system and monitoring systems shall be fully operational upon completion of pipe installation.

#### 1.08 OBSERVATION OF WORK:

- A. Provide access to the project site for City, Architect/Engineer, and manufacturer at all times during installation and to observe finished work.

- B. The Contractor shall give the Architect/Engineer a minimum of seven (7) days advance notice of the start of any work to allow scheduling for field observation of the construction relating to corrosion protection.

#### 1.09 RECORD DRAWINGS

- A. Contractor shall maintain an accurate record of the construction and a marked-up drawing of all construction modifications. At completion of project, the Contractor shall provide a copy of the marked-up construction drawings of the corrosion control installations to the Architect/Engineer for preparation of Record Drawings.

### PART 2 - PRODUCTS

#### 2.01 GENERAL:

- A. Unless otherwise indicated, provide all first-quality, new materials, free from defects, in first class condition suitable for the intended use. Provide materials and equipment, which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to these specifications.
- B. Provide materials intended for this type of service in accordance with this specification and the referenced standards. Whenever the requirements of the Specifications or Plans exceed those of the codes or manufacturer's instructions, the requirements of the Specifications or Plans shall prevail. Where a larger size, higher quality, or better grade of material or a higher standard of workmanship is required, the most stringent requirement shall apply.
- C. The use of a manufacturer's name and model or catalog number is solely for the purpose of establishing the standard of quality and general configuration desired. Products of other manufacturers of equal standard and quality will be considered in accordance with the General Conditions.

#### 2.02 WIRES:

- A. General: Wire shall conform to applicable requirements of NEMA WC 3-80, WC 5-73, and WC 7-88.
  - 1. All cathodic protection wires and cables provided shall be insulated stranded copper wire.
  - 2. Wire size, type, and insulation type as specified in this Section.
- B. Joint Bond Wires:
  - 1. General: Type of joint bonds shall depend on pipe joint coating and shall be either:
    - a. Insulated copper joint bond wires
  - 2. Bond Lengths: Length of bond strap and joint bond wire may be adjusted for different pipe size and joint type per pipe manufacturer's recommendations.
    - a. Provide sufficient slack for pipe or joint movement between each thermite weld connection with each type of bond or strap and fitting or joint type.
      - 1) Minimum slack shall be 1 inch for each end or 2 inches total.
  - 3. Insulated Joint Bond Wires: Provide joint bond wires consisting of single conductor, stranded insulated copper wire with 600-volt high molecular weight polyethylene (HMWPE) insulation.
    - a. Supply all joint bonds complete with a formed copper sleeve on each end of the wire.

- b. Wire conductor for field applied sleeves shall extend 1/4 inch beyond end of copper sleeve. End of factory formed copper sleeves shall be angled so as to allow end of wire to be exposed to thermite weld material.
  - 1) Push-on, mechanical, or flanged joint: No. 4 AWG wires, 18 inches long for 16 inch and smaller pipe and No. 2 AWG wires, 18 inches long for larger pipes.

C. Wire Identification:

- 1. Wire insulation color shall indicate the function of each wire and shall be as shown in the plans and as follows:
  - a. Pipeline test wires:
    - 1) Water Pipeline: Blue stranded wire.
  - b. Foreign Pipeline: White or as requested by foreign pipeline company.
  - c. Unprotected Pipe: Black.
  - d. Anode lead wires: Black.
  - e. Reference electrode wires: Yellow.
  - f. Tracer wires: Tracer wire shall be provided in accordance with Section 312316.13 - Trenching.
    - 1) Colored blue for water lines.
    - 2) Colored green for sanitary sewer lines.

2.03 THERMITE WELD MATERIALS:

- A. Electrical connection of copper wire or copper strap to metallic (steel, ductile iron, and cast iron) fittings, pipe, and structures shall be by the thermite weld (cadweld) method.
- B. Supply the proper size and type of wire sleeves, cartridges, and welder molds as required for each type of connection and pipe material in accordance with the thermite weld manufacturer's written recommendations. Weld materials from different manufacturers shall not be interchanged.
- C. Provide type of charges required for each pipe or fitting base material.
  - 1. Provide steel charges for steel materials (Cadweld F-33 or Thermoweld P Standard Powder). Charge (cartridge) size shall be minimum of 15 grams and maximum of 25-grams for steel materials.
  - 2. Provide cast iron charges for all ductile iron and cast iron materials (Cadweld XF-19 or Thermoweld CI Cast Iron Powder). Charge (cartridge) size shall be minimum of 25 grams and maximum of 32-grams for ductile and cast iron materials.
  - 3. Maximum cartridge size for natural gas and petroleum pipelines and structures shall be 15-grams.
- D. Welder molds shall be graphite molds.
  - 1. Ceramic "One-Shot" molds will not be acceptable.
  - 2. Special welders and materials are required for copper strap, formed joint, and flexible coupling bonds.
  - 3. Vertical type connections require special welders and materials as recommended by the weld manufacturer.
- E. Adapter Sleeves:
  - 1. Install adapter sleeves (Cadweld CAB 133H, Thermoweld A200, or approved equal) for all No. 12 AWG wires. Provide sleeve type as recommended by thermite weld manufacturer and attach in the field.

2. Install adapter sleeves for all No. 4 AWG and No. 2 AWG wires. Either premade factory sleeved wires or wires with sleeves made in the field with the appropriately sized sleeves and hammer die are acceptable.
  - a. Factory formed sleeves shall be beveled to allow molten thermite weld material to directly contact wire.
  - b. Field formed sleeves shall be attached with the appropriately sized and type of hammer die and method as recommended by the thermite weld manufacturer.
  - c. Wire conductor for field installed adapter sleeves shall extend 1/4 inch beyond end of the sleeve to allow molten thermite weld material to directly contact wire.

#### 2.04 THERMITE WELD CAPS:

- A. Thermite weld caps shall consist of a 4-inch by 4-inch size premade weld cap filled with elastomeric mastic coating and suitable primer.

#### 2.05 GROUND CLAMPS:

- A. Ground clamps for wire connections to copper service pipe shall be sized to fit the pipe and wire and UL 467 listed for direct burial in earth or concrete. All parts of the clamp shall be bronze including bolts and nuts, as manufactured by Burndy, O. Z. Gedney, Thomas and Betts, or approved equal.

#### 2.06 GALVANIC ANODES:

- A. General: Zinc or Magnesium anodes shall be used depending on the corrosive characteristics of the soils. CONTRACTOR shall confirm with the City on which type of anode shall be installed.

##### 1. Zinc Anode:

##### a. Zinc Anode Caps:

- 1) Mars Company 6 ounce zinc anode caps or Architect/Engineer approved equal may be substituted for prepackaged anodes in locations where anodes are required, if approved by the Engineer. They shall be placed on all tee bolts.

##### 2. Magnesium Anode:

- a. High-Potential Magnesium Composition for buried soil applications shall have the composition as follows:

| ELEMENT        | CONTENT                              |
|----------------|--------------------------------------|
| Aluminum (Al)  | 0.010% maximum                       |
| Manganese (Mn) | 0.500% to 1.300%                     |
| Silicon (Si)   | 0.05% maximum                        |
| Copper (Cu)    | 0.020% maximum                       |
| Nickel (Ni)    | 0.001% maximum                       |
| Iron (Fe)      | 0.030% maximum                       |
| Total Others   | 0.050% each or 0.300% maximum, total |
| Magnesium (Mg) | Remainder                            |

- b. Prepackaged Magnesium Anode Minimum Dimensions:

|                    | 17 LBS. ANODE | 32 LBS. ANODE |
|--------------------|---------------|---------------|
| BARE ANODE SIZE    |               |               |
| Nominal Bare Anode | 3" x 25"      | 5" x 21"      |

|                      |                |          |
|----------------------|----------------|----------|
| Packaged Weight      | 42 lbs.        | 68 lbs.  |
| Nominal Package Size | 6" diam. x 29" | 7" x 30" |

- c. Acceptable High Potential Magnesium Anodes: Ultra Mag manufactured by Farwest Corrosion Control Company, or Architect/Engineer approved equal.
3. Prepackaged Galvanic Anode General Requirements:
  - a. Anode Wire: Supply each anode with No. 12 AWG stranded copper wire with THWN insulation, 10 feet long minimum.
  - b. Wire-to-Anode Connection: The galvanic anode material shall be cast around a galvanized steel wire, strap, or pipe core. The anode connection to the steel core shall silver-soldered (45% silver) by the manufacturer's standard process and be stronger than the wire. Connection of lead wire to anode shall be electrically insulated with manufacturer's standard waterproof epoxy or electrical potting compound type insulation.
  - c. Prepackaged Anode Backfill: Backfill shall have a grain size so that 100 percent is capable of passing through a 20-mesh screen and 50-percent will be retained by a 100-mesh screen. The backfill mixture shall be thoroughly mixed and firmly packaged around the galvanic anode within the cloth bag or cardboard tube by means of adequate vibration.
    - 1) The complete packaged galvanic anode shall weigh a minimum of 2.0 times the bare anode weight.
    - 2) The quantity of backfill shall be sufficient to cover all surfaces of the anode to a depth of 1-inch.
  - d. Packaging and Shipping: Bare anodes shall be centered in cotton bag filled with specified backfill. Provide electrode packaged in a plastic or heavy multi-walled paper bag of sufficient thickness to protect the anode, wire, backfill, and cloth bag during normal shipping and handling.
  - e. Compliance Statement: Furnish an independent laboratory analysis certifying that all anode and backfill material supplied meets the requirements of this Specification.
  - f. Field Verification: At Architect/Engineer's option, a galvanic anode may be selected at random for Contractor to provide an independent laboratory analysis on to demonstrate anode and backfill material supplied meets the requirements of this Specification.
  - g. Prepackaged Galvanic Anode Backfill Composition:

| ELEMENT                    | CONTENT |
|----------------------------|---------|
| Ground Hydrated Gypsum     | 75%     |
| Powdered Wyoming Bentonite | 20%     |
| Anhydrous Sodium Sulfate   | 5%      |

## 2.07 WIRE CONNECTIONS AND SPLICE MATERIALS:

- A. Compression Connectors: Compression connectors for in-line, multi-splices, and tap splices shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced. Compression connectors shall be applied with the crimp tool and die recommended by the manufacturer for the wire and tap connector size. Acceptable Type "YC" wire compression connectors as manufactured by Burndy Co., or approved equal.
- B. Silver Brazing Alloy: Brazing Alloy with 15 percent silver content, 1185 to 1300 degrees F melting range.

- C. Splice Kits: In-Line splice insulating kit for insulation repair shall be epoxy resin, 3M Company Scotch Cast; Royston Mini Splice-Right; or approved equal.
- D. Electrical Splicing Tape: Tape for wire splice insulation shall be 30 mil linerless rubber high voltage splicing tape, Scotch 130C; and 7 mil vinyl electrical tape, Scotch Super 33+; suitable for moist or wet environments, as manufactured by 3M Products; or approved equal.
- E. Wire Connector Terminals: A ring tongue terminal, or single hole solderless lug (Lug-it) type connector shall be installed on the end of all stranded wire before connecting it to terminal box, or junction box terminal studs.
  - 1. Wire connector terminals shall be sized to fit wire and stud size.
    - a. One-piece copper, tin-plated crimp-on ring tongue terminal. Acceptable ring tongue wire connectors are manufactured by Burndy Co., 3M, Panduit, Thomas and Betts, IDEAL, or approved equal.
    - b. Seamless copper Lug-it type connector rated shall be UL listed for 600 volt service with off-set tongue. Acceptable single hole solderless lugs are manufactured by ILSCO, or approved equal.
- F. Electrical Sealer: Provide electrical sealer Ivy-spray Type Scotch 1603, manufactured by 3M Company, or approved equal.
- G. Electrical Connectors: Hardware used in electrical connections including bolts, studs, nuts, washers, and lock-washers shall be tin or nickel plated copper, brass, bronze, or 300 series stainless steel for electrical conductivity and atmospheric corrosion resistance.

## 2.08 TRACER WIRE:

- A. Tracer wire shall be provided in accordance with Section 312316.13 - Trenching.

## 2.09 WARNING TAPE:

- A. Warning tape shall be provided in accordance with Section 312316.13 - Trenching.

## 2.10 INSULATING JOINTS:

- A. General: Insulating joints shall be dielectric unions, flanges, or couplings. The complete assembly shall have an ANSI rating equal to or higher than that of the joint and pipeline. All materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.
- B. Copper Service Line Insulators:
  - 1. Insulated service fittings shall consist of brass union body that encapsulates nylon insulator specially designed to provide electrical isolation for this type of intended use:
    - a. Insulated corporation ball valves, insulated curb ball valves.
    - b. Service Line Insulators shall be provided to insulate copper or metallic service lines as shown in the Plans.
    - c. Service Line Insulator Model Number will depend on designated insulator location and piping connections.
  - 2. Consult manufacture for model number and installation procedures for each application. Acceptable Service Line Insulators are available from:
    - a. Mueller Co., Decatur, IL (800-423-1323), or approved equal.

## 2.11 LININGS AND COATING:

- A. Supply pipe and fittings with linings and coatings of the same type as adjacent pipe, except where shown in the Plans or called out in the Specifications.
- B. Provide stainless steel materials, or coat all other miscellaneous buried metallic items, (tie rods, thrust restraints, tapping saddles, harnesses, etc.). Coat tie rods and rebar when directly exposed to soil. Provide with factory applied epoxy coating, fusion bonded epoxy coating, heat shrink sleeves, or with coating recommended by coating manufacture for buried application and approved by Architect/Engineer for intended exposure.
- C. Coat metallic pipe and fittings installed above-grade as specified herein. Provide exterior coating for all above-grade piping, fittings, bollards, and vent pipes with two coats of polyamide epoxy coats at 2.5 to 3.5 mils dry film thickness per coat (MDFTPC) and with one topcoat of polyurethane enamel at 3 to 4 MDFT or with a 12-mil fusion bonded epoxy coating system.
  - 1. Minimum surface preparation shall be near-white metal blast (SSPC SP-10) for external surfaces.
  - 2. Color as selected by City.
- D. Coat and line all buried metallic (steel, ductile iron, and cast iron) valves, fittings, miscellaneous piping, and hydrants internally and externally. Supply factory coated valves and fittings with linings and coatings of the same type as adjacent above grade pipe, except where shown in the Plans or where coating or lining specified for buried main pipeline is not feasible for fabricated items or special pipe pieces (such as incidental metallic piping, valves, fittings, flexible couplings, glands, hydrants, etc.).
- E. At Contractor's option, factory coat or line the incidental piping, valves, or fittings with liquid epoxy or with fusion-bonded epoxy coating in accordance with AWWA C116 or AWWA C550.
  - 1. Internal coatings shall be NSF approved for potable water service.
  - 2. Bolts, nuts, and washers (including in valve bonnet and stuffing box) shall be Series 300 stainless steel.
- F. Internal linings and coatings in contact with water shall be NSF approved for potable water service.
- G. All ferrous interior mounting faces/surfaces shall be prepared and shop primed with a suitable rust-inhibitive holding primer applied in accordance with this specification and the coating manufacturer's recommendations.
  - 1. Holding rust-inhibitive primer shall be compatible with specified topcoats.
  - 2. Apply per coating manufacturer's recommendations to a thickness that will not impair the clearances required for proper installation of the joint or fitting (valve) operation.
- H. Ductile Iron and Cast Iron Surface Preparation: Use SSPC SP grades as surface preparation guide only as it applies to cast iron or ductile iron in percentage cleanliness required and surface contaminants removed, not the color of the metal.
  - 1. The abrasive blast cleaning operation shall remove the same percentage of all surface contaminants (including tightly adhered annealing scale) as the SSPC SP grade referenced. The entire surface area shall be abrasive blasted.
  - 2. No rust stains shall be allowed.
  - 3. Avoid over blasting, high nozzle velocities, and excessive blast times.
  - 4. Cast iron and ductile iron attain a gray color when abrasive blasted due to the higher carbon content compared to steel. For example if a SSPC SP-10 Near White Grade is specified for cast iron or ductile iron, the degree of surface cleanliness is comparable to a near white blast for steel and requires 95 percent removal of all surface contaminants including tightly adhered annealing scale. The one exception is that the ductile or cast iron will not be required to be near-white, but will only be required to be a near-gray color.

- I. Liquid Epoxy: Provide factory applied liquid epoxy lining and coating in accordance with AWWA C210 and AWWA C550 and these specifications.
1. Epoxy material shall be the product of a coating manufacturer normally engaged in production of such material and shall be for intended service conditions. Coating in contact with potable water shall be approved for potable contact and conforming to NSF 61.
  2. The liquid epoxy coating shall be a two part chemically cured coating or 100% material.
  3. Coating shall be mixed and applied per coating manufacturer's directions.
  4. Liquid-epoxy lining of metallic pipe and fittings shall be potable grade epoxy coating approved for potable water contact and this type of intended service.
  5. Abrasive blast with material and in manner as recommended by coating manufacturer to produce surface profile depth and angular shape needed. Surface preparation shall be a minimum of SSPC SP-5 (White) for immersion service and SSPC SP10 (Near White) or better for external service.
  6. Coating shall be a minimum of two or more coat system with a minimum thickness of 14 to 16 mils dry film thickness (MDFT).
  7. Minimum adhesion to prepared steel shall be 400 psi per ASTM D1002, or per coating manufacturer's printed literature, whichever is higher.
- J. Fusion-Bonded Epoxy: Provide factory applied fusion-bonded epoxy lining and coating in accordance with AWWA C213, AWWA C116, and AWWA C550, and these specifications.
1. Fusion-bonded epoxy material shall be the product of a coating manufacturer normally engaged in production of such resin and shall be for intended service conditions. Coating in contact with potable water shall be approved for potable contact and conforming to NSF 61.
  2. The fusion bonded epoxy coating shall be a 100 percent powder epoxy based thermosetting coating. Coating shall be applied by flocking, fluidized bed, or electrostatic method per coating manufacturer's directions.
  3. Fusion-bonded epoxy lining of metallic pipe and fittings shall be potable grade epoxy coating approved for potable water contact and this type of intended service.
  4. Abrasive blast with material and in manner as recommended by coating manufacturer to produce surface profile depth and angular shape needed. Surface preparation shall be a minimum of SSPC SP-5 (White) for immersion service and SSPC SP10 (Near White) or better for external service.
  5. Fusion bonded epoxy coating shall be one or two-coat system with a minimum thickness of 8 to 10 mils dry film thickness.
    - a. Fusion-bonded epoxy material shall meet the performance requirements of the referenced AWWA standards. Fusion-bonded epoxy material shall be the product of a coating manufacturer normally engaged in production of such resin and shall be for intended service conditions. The fusion bonded epoxy coating shall be a 100 percent powder epoxy based thermosetting coating. Coating shall be applied by flocking, fluidized bed, or electrostatic method per coating manufacturer's directions. Fusion-bonded epoxy lining of metallic pipe and fittings shall be potable grade epoxy coating approved for potable water contact and this type of intended service. Abrasive blast with material and in manner as recommended by coating manufacturer to produce surface profile depth and angular shape needed. Surface preparation shall be a minimum of SSPC SP-5 (White) for immersion service and SSPC SP10 (Near White) or better for external service. Fusion bonded epoxy coating shall be one or two-coat system with a minimum thickness of 8 to 10 mils dry film thickness (MDFT).
    - b. Minimum adhesion to prepared steel shall be 3,000 psi per ASTM D1002, or per coating manufacturer's printed literature, whichever is higher.
- K. Dry Film Thickness: Conduct dry film thickness measurement and 100% holiday inspection of all epoxy factory coated items prior to shipment. Repair all defects with approved repair material according to coating manufacturer's directions prior to shipment.



- L. Repair Kit: As needed provide repair kit for epoxy-coated materials.

## 2.12 BOLTS, NUTS, WASHERS:

- A. All bolts, nuts, and washers installed below-grade (either buried, submerged, immersed in water, or in vaults) shall be Stainless Steel Series 300.
  - 1. Stainless steel bolts and nuts shall be provided with an anti-galling lubricating compound.
  - 2. Provide with certification that stainless steel bolts, nuts, and washer materials provided were as specified with name of stainless steel manufacturer and Series 300 grade provided.
- B. Stainless steel bolts shall be Type 304SS.
  - 1. Bolt size, lengths, and tensile strength shall be as designed for the application.
- C. Nuts shall be semi-finished heavy hex head Type 303SS (ASTM A194/A194M) and comply with ASTM F594.
  - 1. All nuts shall be fully seated.
  - 2. Nuts shall be compatible with the bolts and have a proof stress equal, or greater than, the tensile strength of the bolts.
- D. Stainless steel washers shall be Type 304.
- E. All bolts and nuts shall be installed according to manufacturer's requirements including the use of anti-galling lubricant compound for stainless steel materials.
  - 1. If galling or seizing of the nut and bolt occurs, they shall be cut off and replaced with a new nut and bolt.
  - 2. Exercise care to assure tightening of the nut is against the flange or gland and not due to galling or seizing.
- F. Galvanized, or black steel materials (piping, nipples, unions, fittings etc.), shall not be used in wet, immersed, buried locations, or vaults unless coated as specified.

## 2.13 PIPE AND FITTING FIELD COATING REPAIR MATERIALS:

- A. Field Coating Repair Materials:
  - 1. Heat Shrink Sleeve and Sleeve Repair Materials: Heat shrink sleeve repair materials shall consist of either heat shrink sleeve in tube form or heat shrink patch kit depending on size and shape of repair.
    - a. Acceptable heat shrink products are Tapecoat TC LS/75 sleeve or Tapecoat TC SL/75 precut repair kit available from The TAPECOAT Company, Evanston, IL.; Raychem WaterWrap sleeve or PERP Repair Patch Kit available from Tyco Adhesive (Polyken Kendall) Mansfield, MA.; CANUSA Aqua-Shield Aqua-Sleeve or CANUSA CRPK Repair Patch Kit available from CANUSA, Inc., The Woodlands, TX.; or approved equal.
  - 2. Tape: Cold-applied field repair polyethylene repair type coatings shall consist of suitable primer and minimum 35-mil thick patch/repair/joint tape with aggressive adhesive and release liner, 4 or 6-inches width. Suitable primer shall be provided with the repair coatings as recommended by the repair-coating manufacturer.

- a. Acceptable products are Tapecoat H35 Gray available from The TAPECOAT Company, Evanston, IL.; Polyken 1027 primer and Polyken 934-35 tape available from Tyco Adhesive (Polyken Kendall) Mansfield, MA.; Tek-Rap 200-23 Series primer and Tek-Rap 280 tape available from Tek-Rap, Inc., Houston, TX.; or approved equal.
- 3. Epoxy Coatings: Provide acceptable epoxy coatings that can cure under wet or dry conditions.
  - a. Acceptable products are "A-788 Splash Zone Compound" by Koppers, Pittsburgh, PA; "Aquata Pox" by Raven (King Adhesive Corporation), St. Louis, MO; "Concresive No. 1438 or No. 1170" by Adhesive Engineering Company, San Carlos, CA; or approved equal.
- 4. Four layer petrolatum wax-tape system (AWWA C-217) intended for burial conditions.
  - a. Acceptable petrolatum coating systems are STAC Coating System as manufactured by Central Plastics Company, Shawnee, OK.; Denso Pipe and Fittings Petrolatum System as manufactured by Denso Products, Houston, TX.; No. 1 Wax-tape Coating Systems for buried locations and No. 2 Wax-tape Coating Systems for above grade and vault applications as manufactured by The Trenton Corporation, Ann Arbor, MI; or approved equal.

### PART 3 - EXECUTION

#### 3.01 GENERAL:

- A. All materials and equipment associated with pipe connecting wires, joint bonding, reference electrodes, galvanic anodes, insulating joints, and casing insulators as shown and specified herein shall be furnished and installed by the Contractor.
- B. Coordinate installation of the specified work as necessary such that installation of the items herein specified can be completed concurrently with pipeline installation. Items not installed before backfilling of the pipe shall be installed at the Contractor's sole expense.
- C. The Contractor shall examine all Plans and coordinate his work so as to avoid conflicts, errors, delays, and unnecessary interference with construction of the facilities and to avoid duplication of the work such as excavation, backfilling, etc.
- D. All work shall present a neat and finished appearance. Any changes in the design or method of installation of an item as specified shall be reviewed and approved by Architect/Engineer prior to installation.
- E. In the event of any conflicts in the Plans or Specifications, the Architect/Engineer shall be consulted. If departures from the Plans are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Architect/Engineer in writing for review as soon as practical, but not later than 30 days before installation.
- F. Weather Conditions: Installation of the corrosion protection system components, such as splices, bonds, and wire installation shall not be allowed when ambient temperature is below or approaching 0° F (-18° C.) to minimize wire insulation damage.

#### 3.02 MATERIAL STORAGE AND HANDLING:

- A. Store materials in secure, protected location.
- B. Store thermite weld materials, prepackaged galvanic anodes, and reference electrodes off the ground and keep them dry at all times.
- C. Protect against weather, condensation, and mechanical damage.

- D. Handle with care to prevent damage. Wire shall not be sharply bent or tightly coiled to minimize possibility of damage to the wire insulation during manufacture, shipment, or installation.
- E. Equipment or materials damaged in shipment, or in the course of installation, shall be replaced. Immediately remove from site all mechanically damaged materials.
- F. Prepackaged anodes or reference electrodes shall be handled with care to prevent loss of backfill material. Do not lift or hold anodes and reference electrodes by the lead wire.

### 3.03 WIRE CONNECTIONS:

- A. The electrical connection of copper wire or copper strap to metallic (steel, cast iron, and ductile iron) surfaces shall be by the thermite weld method. Assure that pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the pipe or fitting wall's integrity or damage the lining in any way.
- B. The Contractor is responsible for repair of any damage to pipe, fitting, lining, or coating as a result of the thermite weld process.
- C. Make thermite weld connections at locations as directed by pipe manufacturer so as to not damage pipe gasket or internal linings exposed to liquid.
- D. The electrical quality and resistance of the connection is dependent on proper adhesion of the welded connection to the pipe or fitting surface. Observe proper thermite weld material selection, safety precautions, surface preparation, and welding procedures as recommended by the material manufacturer.
- E. Connections to gas and petroleum piping systems shall be according to ANSI/ ASME B31.8 and ANSI/ASME B31.4 codes. Maximum charge size shall be 15 grams.
- F. Before the connection is made, clean the surface to bare metal by making a 2-inch by 2-inch window in the coating, and then filing or grinding the surface with a grinding wheel to produce a bright (white) metal finish.
- G. All power grinding shall be with a vitrified type-grinding wheel. The use of resin, rubber, or shellac-impregnated type grinding wheels is not recommended by the thermite weld manufacturer and will not be acceptable.
- H. Contractor shall take appropriate actions for existing coatings with asbestos to minimize worker exposure and to contain, handle, and dispose of asbestos per regulations.
- I. After the surface is cleaned to a smooth, white metal finish, lightly tap the pipe surface so as to produce dimples to improve surface profile and adhesion for the weld material. In cold weather or on cold or wet surfaces, preheating of the metal surface may be required to improve successful connections. Exothermic welding should be completed immediately following preparation of the metal surface before surface flash rusting or oxidation can occur.
- J. Where specified wire sleeves shall be firmly attached to the end of the wire before thermite welding to the metal surface. Wire and sleeve shall be clean and dry. Wire shall extend 1/4-inch out of field formed sleeves. Factory formed sleeves shall be provided with end of sleeve angled so that wire is exposed to thermite weld material.
- K. The mold and base metal should always be clean and dry. Replace worn molds at intervals as recommended by manufacturer.

- L. Place a metal disk in the bottom of the graphite mold and then pour in the weld material. Be sure to squeeze the plastic cylinder to get all of the starting powder out. Close the mold body lid. Place the graphite mold on the prepared pipe surface and install the wire in the slot at the bottom of the mold. Hold the wire and mold steady and firm on the pipeline.
- M. Ignite the weld material with the spark gun. Lightly tap the mold body during the ignition fusion process. Carefully remove the graphite mold after the fusion process is completed.
- N. Care should be taken during the thermite welding process, as the exothermic process is extremely hot (4,000 degrees F). Do not breathe the fumes.
- O. The graphite mold should not be touched or allowed to come in contact with the pipe coating or other flammable or meltable materials, as it is extremely hot. Carefully clean the slag out of the graphite mold body.
- P. Pipe coating shall be protected during thermite welding procedure. Coating damaged by welding or weld splatter shall be repaired per this specification. Welded area shall be allowed to cool to "warm to touch" condition prior to application of primer and field coating.
- Q. After the weld connection has cooled, remove slag, visually and physically test quality of connection by tapping with a hammer and lightly pulling on the wire. The completed weld should visually present a good appearance of a well-formed connection with a minimum loss of weld material or splatter. All portions of the wire and sleeve shall be covered with the weld material. Remove and replace all visually defective welds.
- R. Attach copper wire to copper service lines with grounding clamp.

#### 3.04 WIRE CONNECTION COATING:

- A. Clean weld area, prime, and install a prefabricated thermite weld cap per manufacturer's directions over each completed connection after testing unless to be coated by heat shrink joint coating. In cold weather, store primer and cadweld cap materials in a heated location and keep warm until installation.
- B. The pipe and factory-coating surface shall be clean and dry before application of primer. Primer shall be thoroughly mixed and applied to pipe surface in an even manner to obtain a minimum dry film thickness of 1 mil. Primed area shall provide uniform coverage around cadweld area and extend a minimum of 3 inches onto coated surface. Skips or misses and runs and sags shall be reprimed or repaired to provide even uniform coverage.
- C. Primed surface shall be kept free of all contamination. Allow primer to dry for one to five minutes depending on application and weather conditions. Primer shall be dry-to-touch condition and have a non-glossy appearance, before application of prefabricated cadweld cap.
- D. Prefabricated cadweld cap shall be applied at connection according to manufacturer's directions. The filler material shall be placed over the thermite weld connection and worked around and under the wire and connection. Apply pressure to the prefabricated cadweld cap to assure good adhesion.
- E. Completed cadweld cap assembly shall adhere tightly to pipe and wire connection with no voids or gaps. Inadequate adhesion is demonstrated if there are visible gaps or voids under the cap or if the cap can be easily removed from the pipe surface by pulling with fingertip pressure. At all locations where inadequate adhesion is evident, reprime and replace cap or prime and apply either a minimum 6-inch by 6-inch square of field repair tape, a 55-mil thick Tapecoat Gray "Pads", or heat shrink repair material over existing cadweld cap. Apply per tape coating or heat shrink manufacturer's directions.

- F. Wire connections at pipe joints or fittings to be coated with heat shrink sleeve do not require cadweld cap assembly. Wire connections shall be completely encapsulated under heat shrink sleeve.
- G. All exposed metallic surfaces not covered by the thermite weld cap or heat shrink sleeve shall be repaired as referenced in this specification.

### 3.05 PREPACKAGED GALVANIC ANODE INSTALLATION:

#### A. General:

1. Remove plastic or paper shipping wrap from prepackaged anode prior to placement. Galvanic anodes packaged in cardboard type chip-tube shall be thoroughly perforated just prior to installation.
2. Install galvanic anodes a minimum of 1 foot below the pipe invert and 3 to 5 feet from buried metallic piping or 3-feet from metallic fittings to be protected.
3. Space galvanic anodes equally around the fitting, pipe section, or appurtenance. Locate at bottom edge of pipe trench as shown in the Plans or as specified.
4. Alternate anode placement on opposite sides of the pipe. If two or more anodes installed at the same location, place on opposite side of the pipe or fitting. Provide a minimum anode spacing of 5 feet from other unprotected pipelines.
5. If two or more anodes are installed at the same location, place on opposite sides of the pipe or fitting.
6. Provide a minimum anode spacing of 5 feet from other unprotected pipelines.
7. Handle prepackaged anode with care. Damage to the anode, anode to wire connection, or prepackaged backfill bag will require replacement of the entire assembly.
8. Place anode in native earth backfill do not use pipe zone bedding material.
9. Earth backfill around each anode shall be thoroughly compacted to a point 1 foot above the anode. Backfill material around each anode shall be native soil free of roots, organic matter, trash, and rocks. Stop backfill at specified grade to allow for placing of topsoil, pavement, or concrete, when required.
10. All anode wires shall be buried a minimum of 36 inches below finish grade. Wires shall be handled with care. Splices or damage to the insulation on any wire shall be repaired in accordance with this specification.
11. Electrical connection of the anode wire to steel, cast or ductile iron metallic pipe or fittings shall either be directly to the pipe or fitting by the thermite weld method.
12. Electrical connection to copper services shall either be directly to the copper service by a ground clamp.

#### B. Installation:

1. Each buried or submerged metallic (steel, ductile, or cast iron) pipeline section, appurtenance, valve, or fitting and copper service shall receive a minimum of one galvanic anode.
2. Where two or more metallic fittings are adjacent to each other and install the specified quantity of galvanic anodes for each metallic pipe section, appurtenance, valve, or fitting used in conjunction with nonmetallic pipe.
3. At the Contractor's option, larger anodes may be used in place of multiple smaller anodes for a group of bonded metallic components on non-metallic piping provided the same total bare weight of galvanic anode is used.
4. The minimum number of anodes to be installed on buried or submerged factory coated metallic fittings, pipeline sections, or appurtenances with non-metallic pipelines shall be:

|                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p style="text-align: center;">PREPACKAGED ANODE FOR FITTINGS FOR DIFFERENT NON-METALLIC PIPE SIZES<br/>(17 pound Magnesium or 18 pound Zinc Anodes)</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|

| ITEM                                                                                                                   | 16" or Less | 18" - 30" | 32" - 46" | 48" < |
|------------------------------------------------------------------------------------------------------------------------|-------------|-----------|-----------|-------|
| Single Coated Metallic Fitting                                                                                         | 1           | 1         | 2         | 3     |
| Multiple (2 to 3) Coated Metallic Fittings                                                                             | 1           | 2         | 3         | 4     |
| Coated Fire or Flushing Hydrant with 6" coated metallic pipe leg or plastic pipe leg and plastic pipe main (< 20' leg) | 2           | 2         | 2         | 2     |
| 1" Coated Copper Service Line (< 20' service insulator)                                                                | 1           | 1         | 1         | 1     |
| 1" Bare Copper Service Line (< 20')                                                                                    | 1           | 1         | 1         | 1     |
| Existing Metallic Pipe Tie-In, Leak Location, or Concrete Encased Stub Piece                                           | 1           | 1         | 1         | 1     |

- a. When a 17 or 18 pound anode is required and coating thickness is not as specified, the Contractor shall either install:
  - 1) One (1) 30-pound anode or
  - 2) Two (2) 17-pound Magnesium / 18-pound Zinc anodes
- b. Existing fittings that are exposed and coated with a four-layer petrolatum tape type coating system, shall receive double the number specified or the next largest anode size shown in these specifications. For example, a bare fitting (16-inch or less) is exposed and petrolatum tape coated, it shall receive a 17 or 18 pound size anode.
- c. For ductile iron and cast iron fittings where specified coating thickness, holiday testing, and/or 100% holiday free coating are not completed by the manufacturer, or bare fitting is coated with petrolatum tape type coating system the Contractor shall install one size larger anode or double the number of anodes (17 pound Magnesium or 18 pound Zinc) for each fitting listed in table above.
- d. Zinc anode caps may be substituted for prepackaged zinc anodes in locations where zinc anodes are required. They shall be Mars Compan six-ounce (6 oz) caps, and they shall be placed on all tee bolts.

### 3.06 REFERENCE ELECTRODE INSTALLATION - TIGHT BONDED COATED PIPE

- A. Prepackaged Reference Electrodes: Remove reference electrode and cloth bag from the shipping bag and place 6 inches from the pipe below the centerline of the pipe in a horizontal position. Do not hold or lower the reference electrode by the wire lead. Prepackaged reference electrode shall be backfilled with clean native soil.

### 3.07 WIRE INSULATION REPAIR:

- A. Wire splices shall be made with suitably sized Type C compression connectors as specified, or mechanically secured and soldered with rosin cored 50/50 solder. Inline type butt connectors are not allowed.
- B. Minor insulation damage to small cathodic protection wires (equal to or smaller than No. 8 AWG) shall be repaired by spirally wrapping (minimum of 50 percent overlap) with two layers of high voltage rubber splicing tape and two layers of vinyl electrical tape.
- C. Insulation damage or splices to large cathodic protection cables (No. 4 AWG or larger) shall be made with epoxy insulated splice kits (3M Scotchcast 90-B1 or 82-A1 or approved equal). Allow epoxy splice kits to cool and set before moving.
- D. All wire splices and wire insulation repair locations shall be approved by Architect/Engineer.

### 3.08 WARNINGTAPE:

- A. Bury warning tape above all underground cathodic protection cable, conduit, and/or all pipelines. Warning tape shall be placed approximately 18 - 24 inches below the ground surface, or at specified depths as required in other sections of these Specifications or as shown on the construction plans. Align parallel to and within 2 inches of the centerline of pipe run.
- B. PIPE TRACING WIRE:
  - 1. Insulated tracer wire shall be installed on all non-metallic pipe sections.
  - 2. Pipe tracing wire shall be taped to top of plastic or non-metallic pipeline at a maximum distance of every 10 feet with polyethylene tape.
  - 3. Do not attach tracing wire directly to metallic fittings or appurtenances.
  - 4. Install approved tracer wire access boxes at all fire hydrant assemblies.
  - 5. Maximum tracer wire span distance shall be 500 feet.
    - a. If no existing pipe appurtenances are available for a distance up to 1,000 feet, then install either a post or flush type tracer wire access boxes.
    - b. Equally divide span distance and install tracer wire access box at mid-point in a protected location.
    - c. Selection of type and location of tracer wire terminal box will depend on field conditions and shall be in accordance with Architect/Engineer's directions.
  - 6. Field terminate tracer wires in accordance with the plans by:
    - a. Bring end of tracing wire leg to near ground surface elevation by installing a tracer wire flush or above grade access box or test station.
    - b. Terminate tracing wire above grade at flush or above grade test access boxes or test stations located next to pipe appurtenances (vaults, vent pipes, blow-offs, or at fire hydrant bases).
    - c. Make tee or inline splices and insulate as specified within this specification.
    - d. Tracing wire shall be terminated inside tracer wire boxes where available on a separate terminal from anode or pipe/fitting leads.
    - e. At bases of above grade structures terminate in a flush or above grade access boxes.
    - f. Above grade terminations next to above grade appurtenances shall consist of a minimum 3/4-inch diameter, 3 foot long rigid galvanized steel conduit terminated approximately 6-inch above grade in an above grade access box.

- g. Terminate in vaults next to ladder to allow easy access for attachment, or drill vault and terminate outside vault next to the vent pipe (if present).
- h. Test tracer wire for continuity prior to final acceptance of the pipeline installation.

### 3.09 INSULATED JOINTS:

- A. Install copper insulating joints where copper services are connected to metallic water mains and at service meters or curb stops where ownership of copper service changes.
- B. Carefully align and install insulating joints according to the manufacturer's recommendations to avoid damaging insulating materials.

### 3.10 COATING FOR PIPING, FITTINGS, AND ACCESSORIES:

- A. Install coated valves, fittings, and miscellaneous metallic pieces so as to not damage coating or lining. Conduct dry film measurements and holiday test to confirm conformance with specifications and referenced standards.
- B. Provide corrosion protection for ferrous metal piping appurtenances such as tie-rods, thrust restraints, tapping saddles and bands, harnesses, and similar items: Stainless steel, fusion bonded epoxy coated, or heat shrink tube wrapped.
- C. Coat restraining harnesses, rebar, or tie-rods where utilized as tie-downs or thrust restraints and exposed to soil or liquid with field applied four-layer petrolatum tape system.
- D. Flange bolts, Nuts, and Similar Items: Series 300 stainless steel or fusion bonded epoxy coated.
- E. Conduct testing of Series 300 stainless steel materials with magnet to confirm stainless steel provided prior to installation.
- F. If approved by Architect/Engineer, coat miscellaneous hard to coat items with four-layer petrolatum tape system or heat shrink repair coating.

### 3.11 PIPE AND FITTING COATING REPAIR:

- A. Inspect and repair any coating or lining damage with original manufacturer's approved repair kit. Follow coating manufacturer's written directions for surface preparation and repair coating application. Utilize potable water approved materials for coatings and linings in contact with potable water.
- B. Field coating for field repair of damaged coating on new or existing pipe, piping, appurtenances, and fittings shall be in accordance with this specification.
- C. External pipe and fitting repair coatings shall consist of external coating materials and repair procedures as recommended by the pipe or fitting coating manufacturer.
- D. Fusion-bonded epoxy coated items shall be repaired with liquid epoxy repair kits provided by the fusion-bonded coating manufacturer.
- E. Epoxy coated items shall be repaired with repair coating from the original coating manufacturer.
- F. Spot coating damage at thermite weld connections not covered by standard thermite weld cap coating repair procedure shall be repaired with a field applied 6-inch minimum piece of tape coating, 6-inch minimum size of heat shrink repair material, or a 100 percent solids epoxy coating that can cure in either wet or dry conditions.



- 3.12 FIELD COATING FOR STEEL AND DUCTILE IRON STUB PIECES, COPPER SERVICE PIPING, AND ISOLATED COPPER FITTINGS:
- A. Field tape coat or heat shrink sleeve, short sections of buried metallic piping such as vent pipes, blow-off assemblies, and pipe stubs to be concrete encased under or next to buildings or tanks if not already coated with an approved specified factory applied coating system.
1. Bituminous asphaltic coating does not qualify as an approved factory coating.
- B. Field coat buried copper service, copper fittings, or galvanized steel service piping.
1. Follow this specification, the coating manufacturer's recommendations, and the referenced AWWA Standards.
2. Hand tool clean surfaces.
- a. Copper service lines shall not be sandblasted.
- b. Field Tape Coating:
- 1) For hand taping, provide suitable field primer (if required) and 35-mil field applied repair tape with aggressive adhesive and release liner, 4 or 6-inches width.
- 2) Pipe shall be clean and dry prior to and during application of both primer and tape coating. Tape shall be applied in a spiral wrap with a 50 percent overlap in accordance with AWWA C209 Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
3. Heat Shrink Field Coating:
- a. For heat shrink sleeve installation, provide suitable filler material and heat shrink sleeve material for pipe size required.
- b. Pipe shall be clean and dry prior to and during installation of heat shrink sleeve. Install sleeve in accordance with AWWA C216, Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
4. Petrolatum Tape Coating System
- a. Field apply petrolatum tape system for all restraining fittings and rods if not already coated with an approved specified factory applied coating system.
- b. Provide petrolatum system coating for isolated copper fittings if not already protected by a galvanic anode system.
- c. For petrolatum system tape installation (AWWA C217), provide suitable primer, filler material (mastic), petrolatum tape and outer wrap material for burial applications.
- 1) Pipe or fitting shall be clean and dry prior to and during installation of four-layer petrolatum wax tape system.
- 2) Install petrolatum tape system in accordance with coating manufacturer's instructions and these specifications.
- 3) Apply primer in an even uniform manner to entire tie rod, pipe, or fitting surface area to be coated to achieve minimum primer thickness of 3-mil wet film thickness. Increase amount of primer at and work primer into threads, cavities, pits, angles, edges, and other irregular areas. Apply primer with brush or glove.
- 4) Apply mastic or tape immediately after application of primer, drying of primer is not required.
- 5) Work and mold mastic into irregular shapes so as to fill voids and achieve a uniform contour to provide a smooth even support for the tape coating system to avoid bridging.
- 6) Apply petrolatum tape layer in a spiral wrap fashion around the tie rod or fitting circumference with a 50 percent minimum overlap onto the proceeding layer.
- 7) Apply the 10-mil PVC outer wrap tape layer in a spiral fashion around the pipe or fitting with a 50 percent minimum overlap.

- 8) The completed petrolatum coating system shall be a minimum of 40 MDFT and adhere tightly to the coated structure and present a smooth unwrinkled appearance.

END OF SECTION 331200

## SECTION 331210 - DISINFECTING WATER PIPING SYSTEMS

### PART 1 - GENERAL

#### 1.01 SCOPE:

- A. The work covered consists of the testing, cleaning, and disinfection of all portions of the water system, including valves and stops, service lines to the curb stops, fire hydrants, etc.

#### 1.02 RELATED WORK

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 331100 - Water Main
- C. Section 331120 - Fire Hydrants
- D. Section 331150 - Water Service

#### 1.03 REFERENCE STANDARDS

- A. AWWA C651 - Disinfecting Water Mains.
- B. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
- C. NSF 61 - Drinking Water System Components - Health Effects.

#### 1.04 PLAN:

- A. The Contractor shall submit a waterline system testing, cleaning and disinfection plan 7 days prior to performing any work associated with testing the waterline to the Architect/Engineer for approval. The flushing and testing plan submitted shall have a schedule on when the work will be completed and describe how the waterlines will be tested, disinfected, flushed, and how turbidity will be checked in the area prior to final flushing.

#### 1.05 COORDINATION:

- A. The Contractor shall request the presence of the Architect/Engineer for waterline flushing, testing, cleaning, and sterilizing, providing 48-hour advance notice. The Architect/Engineer shall contact the City's Engineering Project Manager, who will schedule the necessary staff to be present. If City's staff arrives and the testing is cancelled or delayed by more than 15 minutes, a minimum 2-hour charge for the staff's time shall be paid to the City by the Contractor. Rates shall be in accordance with the City's utility labor and equipment rates.

### PART 2 - PRODUCTS

### PART 3 - EXECUTION

#### 3.01 FLUSHING AND TESTING:

- A. General: After the pipe has been laid with all joint restraint and/or solid thrust blocking in place and partially or fully backfilled, all newly laid pipe, or any valved section thereof shall be subjected to a combination hydrostatic pressure and leakage test.

1. Contractor shall notify the Architect/Engineer at least forty-eight hours prior to all testing. Architect/Engineer will be present at all tests.
2. Contractor shall use potable water for all testing, cleaning, and sterilizing.
3. Prior to disinfection and testing, an initial flush at a minimum velocity of 3.0 feet per second (fps), shall be made to clean the line, with the duration of this flush sufficient to displace at least twice the pipe volume of the length of line being flushed. The table below provides information on orifice sizes needed to attain the 3.0 fps flushing velocity. Flushing velocity requirements for water service lines which will also be used for fire suppression systems will be per Section 331150 - Water Service. The Contractor shall coordinate so that the Engineer is present to witness the flushing.
  - a. The Contractor shall coordinate so that the Engineer is present to witness the flushing.

| Orifice Sizes on Hydrant Connections to Achieve 3.0 fps (40 psi Residual Pressure) |                                        |                   |                        |  |                          |
|------------------------------------------------------------------------------------|----------------------------------------|-------------------|------------------------|--|--------------------------|
| Pipe Size (in)                                                                     | Flow Required to Produce 3.0 fps (GPM) | Orifice Size (in) | No. of Hydrant Outlets |  | Hydrant Outlet Size (in) |
| 4                                                                                  | 117                                    | 15/16             | 1                      |  | 2-1/2                    |
| 6                                                                                  | 264                                    | 1-3/8             | 1                      |  | 2-1/2                    |
| 8                                                                                  | 470                                    | 1-7/8             | 1                      |  | 2-1/2                    |
| 10                                                                                 | 733                                    | 2-5/16            | 1                      |  | 2-1/2                    |
| 12                                                                                 | 1055                                   | 2-13/16           | 2                      |  | 2-1/2                    |
| 14                                                                                 | 1436                                   | 3-1/4             | 2                      |  | 2-1/2                    |
| 16                                                                                 | 1876                                   | 3-5/8             | 2                      |  | 2-1/2                    |

- a. Flushing for a water main serving a building fire suppression system shall be flushed at a minimum velocity of 10 feet per seconds per NFPA 24. Contractor shall confirm with the Fire Suppression Designer on the required flows.
  4. The Contractor shall provide test equipment including test pumps, gauges, instruments, taps, piping, valves and other equipment required.
    - a. This includes a temporary flushing setup approved by the Architect/Engineer, if a fire hydrant is not available.
    - b. Pressure gauges used shall be graduated in increments not greater than 5 psi and shall have a range of 50% more than the test pressure. Use only recently calibrated gauges and instruments.
    - c. Prior to testing, remove from systems all equipment which would be damaged by test pressure. Replace removed equipment after testing.
  5. Any section of pipe provided with thrust blocks shall not be tested until 7 days after the concrete has been placed, or the concrete has reached 80% its design strength.
  6. Where thrust restraint is required, but not part of this project, temporary thrust restraint is to be provided by the Contractor.
  7. Pressure tests shall be conducted against all valves and curb stops.
    - a. In the event that no valves are shown in the drawings that would allow for the Contractor to test against them, the Contractor should make provisions to perform testing without the use of the valves, such as by installing temporary plugs and thrust restraints.
    - b. Any additional valves installed by the Contractor for testing purposes shall be paid for by the Contractor.
- B. Procedure: Before applying the specified test pressure, all air shall be expelled from the pipe. The Contractor shall make any necessary taps at points of highest elevation before the test is made and insert the plugs after the test has been completed.

1. The pipe shall be slowly filled with water, and the specified test pressure, corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Architect/Engineer.
    - a. The pump, pipe connection, and all necessary apparatus shall be furnished by the Contractor.
  2. The length of time for a combination pressure and leakage test shall be a minimum of two (2) hours.
  3. The test pressure to be used shall be at least one and one-half times the working pressure, with a minimum of 125 psi for all lines except lines providing supply for a building fire suppression system or as otherwise noted in the construction plans.
    - a. Minimum pressure for a water line serving a building fire suppression system shall be 200 psi, or 50 psi in excess of the system working pressure, whichever is greater, per NFPA 24.
    - b. Pressure shall be maintained at gauge pressure of +/-5 psi for 2 hours.
    - c. Test pressure shall not exceed pipe or thrust restraint of manufacturer's maximum design pressure.
    - d. Not exceed twice the rated pressure of the valves or hydrants when the pressure boundary of the test section includes closed gate valves or hydrants.
    - e. Final test pressures shall be approved by the Architect/Engineer.
- C. Allowable Leakages: The allowable leakage during the duration of the test shall not exceed the amount as determined from the following formula as appropriate:
1. Ductile Iron Pipe and PVC Pipe:  $L = (S \times D \times P^{0.5}) / 148,000$ 
    - a. L = leakage in gallons per hour
    - b. S = length of pipe tested in feet
    - c. D = the nominal diameter of the pipe in inches
    - d. P = the average test pressure during the test in pounds per square inch
  2. Leakage is defined as the quantity of water to be supplied into the pipe, or any valved section thereof, necessary to maintain the specified test pressure after the pipe has been filled with water and air expelled.
- D. Witness of Testing
1. All pressure and leakage tests shall be witnessed by the Architect/Engineer. The Owner's representative shall also be notified a minimum of 48 hours prior to the testing in case they would elect to also witness these tests.
- E. Test Results: Any cracked or defective pipes or fittings discovered in consequence of the pressure test shall be replaced with sound material. Should any test of pipe laid disclose leakage greater than that specified above, the Contractor shall locate and repair the defective joints, until the leakage is within the specified allowance.
1. The Contractor may fully backfill the pipe trench prior to hydrostatic test if the trench is interfering with traffic flow, job site access or normal operations. However, it shall be understood to be the Contractor's risk if the pipe will not reach the test results specified herein. If this occurs he must find the leaks and do the required excavation and pipe repair even though a fully backfilled trench will make this more involved and difficult.
  2. If warranted, one additional test may be requested by the Architect/Engineer on any section of waterline being tested at no additional cost to the Owner.
  3. Any section of pipe which fails the leakage test shall be repaired at the Contractor's expense. This section shall be retested after repairs are made.

### 3.02 STERILIZING WATER MAINS:

- A. General: Disinfection of water mains shall be done in accordance with "AWWA Standard for Disinfecting Water Mains", AWWA C651. The interior of all pipes, fittings and other accessories shall be kept free from dirt and foreign matter at all times. Prior to disinfection, all lines shall be flushed to remove anything that may have entered the pipe during construction, unless approved by the Architect/Engineer to utilize only a final flush.
- B. Chlorination:
1. Form of Chlorine and Means of Application: Before being placed in service, all new water distribution systems and repaired portions of, or extensions to, existing systems shall be chlorinated. If the available water is more alkaline than pH 8, the holding time in the main shall be increased at the discretion of the Architect/Engineer.
  2. Form of Applied Chlorine: Any of the following methods of procedure shall be followed, subject to the approval of the Architect/Engineer.
    - a. Liquid Chlorine: Liquid chlorine shall be used only when suitable equipment is available and only under the direct supervision of a person familiar with the physiological, chemical, and physical properties of the element and who is properly trained and equipped to handle any emergency that may arise. Introduction of chlorine gas directly from the supply cylinder is unsafe and shall not be permitted.
      - 1) A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device with a booster pump for injecting the chlorine-gas water mixture into the main to be disinfected.
      - 2) Direct feed chlorinators are not recommended because their use is limited to situations where the water pressure is lower than the chlorine cylinder pressure.
      - 3) Chlorination devices for feeding solutions of the chlorine gas or the gas itself must provide means for preventing the backflow of water into the chlorine cylinder.
    - b. Hypochlorite: On approval of the Architect/Engineer, a mixture of water and a chlorine-bearing compound of known chlorine content may be substituted as an alternative for liquid chlorine.
      - 1) Calcium Hypochlorite
        - a) Calcium hypochlorite contains 65 percent available chlorine by weight.
        - b) The calcium hypochlorite should first be made into a paste and then thinned to a slurry with clean water, to a one percent chlorine solution (10,000 PPM), then injected or pumped into the newly laid pipe after preliminary flushing. Special attention should be given to the chlorine content of the product used when determining the mixture to obtain the one percent chlorine solution.
        - c) The preferred point of application of the chlorinating agent shall be at the supply end of the pipeline extension, or any valved section of it, and through a corporation stop inserted in the top of the newly laid pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension.
      - 2) Sodium Hypochlorite:
        - a) Sodium hypochlorite is supplied in strengths from 5.25 to 16 percent available chlorine. It is packaged in liquid form in glass, rubber, or plastic containers ranging in size from 1 quart bottles to 5 gallon carboys. It may also be purchased in bulk for delivery by tank truck.
        - b) The chlorine-water solution is prepared by adding hypochlorite to water. Product deterioration must be reckoned with in computing the quantity of sodium hypochlorite required for the desired concentration.
      - 3) Application

- a) The hypochlorite solutions shall be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump. Feed lines shall be of such material and strength as to withstand safely the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the hypochlorite solution is applied to the main.
3. Methods of Chlorine Application
- a. Continuous Feed Method
    - 1) This method is suitable for general application.
      - a) Water from the existing distribution system or other approved sources of supply shall be made to flow at a constant, measured rate into the newly laid pipeline. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The 2 rates shall be proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 6.67 oz / 1000 gal (50 mg/l) available chlorine. To ensure that this concentration is maintained, the chlorine residual should be measured at regular intervals.
      - b) The Table below gives the amount of chlorine residual required for each 100 foot of pipe of various diameters. Solutions of 1% chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires approximately 1 lb of calcium hypochlorite in 8-1/2 gallons of water.
      - c) During the application of chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with chlorine solution. The chlorinated water shall be retained in the main for at least 24 hours during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this 24 hour period, the treated water shall contain no less than 10 mg/l chloring throughout the length of the main. The chlorinated water shall be retention shall not exceed 72 hours.

| Chlorine Required to Produce 50 mg/l concentration in 100 feet of pipe |               |             |
|------------------------------------------------------------------------|---------------|-------------|
| Pipe Size                                                              | 100% Chlorine | 1% Chlorine |
| inch                                                                   | lb            | lb          |
| 4                                                                      | 0.027         | 0.33        |
| 6                                                                      | 0.061         | 0.73        |
| 8                                                                      | 0.108         | 1.30        |
| 10                                                                     | 0.117         | 2.04        |
| 12                                                                     | 0.240         | 2.88        |

- b. Slug Method
  - 1) This method is suitable for use with mains of large diameter for which, because of the volumes of water involved, the continuous feed method is not practical.

- 2) Water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipeline. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The 2 rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of at least 300 mg/l for at least 3 hours. The application shall be checked at a tap near the upstream end of the line by chlorine residual measurements.
  - 3) As the chlorinated water flows past tees and crosses, related valves and hydrants shall be operated so as to disinfect appurtenances.
- c. Tablet Method
- 1) Tablet disinfection is a requirement for a short extensions up to 500 feet for pipe 12 inches in diameter and smaller. Because the preliminary flushing step must be eliminated, this method shall be used only when scrupulous cleanliness has been exercised. It shall not be used if trench water or foreign material has entered the main or if water is below 41°F.
  - 2) Tablets are placed in each section of pipe and also in hydrants, hydrant branches, and other appurtenances. They shall be attached by an adhesive, except for the tablets placed in hydrants and in the joints between the pipe sections. All the tablets within the main must be at the top of the main. If the tablets are fastened before the pipe section is placed in the trench their position should be marked on the section to ensure that there will be no rotation. In placing tablets in joints, they are either crushed and placed on the inside annular space, or, if the type of assembly does not permit, they are rubbed like chalk on the butt ends of the sections to coat them with calcium hypochlorite.
  - 3) The adhesive shall meet NSF 61, AWWA C651 or other food grade alternative only as approved by the Architect/Engineer. There shall be no adhesive on the tablet except on the broad side next to the surface to which the tablet is attached.
  - 4) Filling the Contact
    - a) When installation has been completed, the main shall be filled with water at a velocity of less the 1 foot/second. This water shall remain in the pipe for at least 24 hours.
    - b) Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water.
    - c) The Architect/Engineer and City Water Division representative shall be present during the Disinfection/Dechlorination filling and flushing procedures.

| <b>Number of Hypochlorite Tablets of 5-G required for dose of 50 mg/l*</b> |                            |   |   |   |    |    |
|----------------------------------------------------------------------------|----------------------------|---|---|---|----|----|
| Length of Section                                                          | Diameter of Pipe in Inches |   |   |   |    |    |
| (feet)                                                                     | 2                          | 4 | 6 | 8 | 10 | 12 |
| 13 or less                                                                 | 1                          | 1 | 2 | 2 | 3  | 5  |
| 18                                                                         | 1                          | 1 | 2 | 3 | 5  | 6  |
| 20                                                                         | 1                          | 1 | 2 | 3 | 5  | 7  |
| 30                                                                         | 1                          | 2 | 3 | 5 | 7  | 10 |
| 40                                                                         | 1                          | 2 | 4 | 6 | 9  | 14 |

\*based on 3-3/4 g available chlorine per tablet.



4. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/l. Points of discharge of heavily chlorinated water shall be permitted by the Contractor through the Wyoming Department of Environmental Quality. The chlorinated water shall be dechlorinated prior to discharge. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline. All testing requirements are the responsibility of the Contractor. All circumstances causing failing tests shall be corrected, and retesting shall occur until passing tests are achieved. Contractor must provide Architect/Engineer with all passing test results prior to placing the water system into service. A City Water Division representative shall be present during the Disinfection/Dechlorination filling and flushing procedures.
5. Bacteriologic Tests
  - a. After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. If the number and frequency of samples is not prescribed by the public health authority having jurisdiction, at least 1 sample shall be collected from chlorinated supplies where a chlorine residual is maintained throughout the new main. From chlorinated supplies, at least 2 samples shall be collected at least 24 hours apart.
    - 1) Samples shall be collected the length of the line at every 1200 feet, as well at its end. Sample frequency may be increased in the event of failed tests and heavy contamination as determined by the Architect/Engineer.
  - b. Samples for bacteriologic analysis shall be collected in sterile bottle treated with sodium thiosulfate. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.
  - c. Repetition of Procedure: If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples are obtained. The tablet method cannot be used in these subsequent disinfections. When the samples are satisfactory, the main may be placed in service.
6. Procedure after Cutting into or Repairing Existing Mains: The procedures outlined in this section apply primarily when mains are wholly or partially dewatered. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.
  - a. Trench "Treatment": When an old line is opened, either by accident or design, the excavation will likely be wet and badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to an open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.
  - b. Main Disinfection: The following procedure is considered as a minimum that may be used.
    - 1) Swabbing with Hypochlorite Solution: The interior of all pipe and fittings used in making the repair (particularly couplings and tapping sleeves) shall be swabbed with a 5% hypochlorite solution before they are installed.
    - 2) Flushing: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions is recommended. Flushing shall be started as soon as the repairs are completed and continue until discolored water is eliminated.

- 3) Repair Slug Method: Where practicable, in addition to the swabbing procedures detailed in this section, a section of main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated as specified in the Slug Method Section of this Specification, excepting the dose may be increased to as much as 500 mg/l and the contact time reduced to as little as one-half hour. After chlorination, flushing shall be resumed and continued until discolored water is eliminated.
- 4) Sampling: Bacteriologic samples shall be taken after repairs to provide a record by which the effectiveness of the procedures used can be determined. If the direction of flow is unknown, samples shall be taken on each side of the main break o.

END OF SECTION 331210

## SECTION 333100 - SANITARY SEWER PIPING

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work includes furnishing and installing all sanitary sewer piping on the project.
- B. Unless obtained by the Architect/Engineer, a permit for the sanitary service line work shall be obtained from the City. All sanitary service line work shall comply with City Codes and the currently adopted Plumbing Code. Inspection by the City shall be arranged for when required.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312316.13 - Trenching
- C. Section 330200 - Underground Utilities
- D. Section 330500 - Manholes
- E. Section 331110 - Water Valves and Valve Boxes

#### 1.03 REFERENCE STANDARDS

- A. ASTM C 1103 - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
- B. ASTM C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- C. ASTM C828 - Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.
- D. ASTM C1244/C1244M - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
- E. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- F. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- G. ASTM D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- H. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- I. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- J. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- K. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- L. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

- M. ASTM F794 - Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- N. ASTM F1417 - Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.
- O. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Waterworks.
- P. NSF 61 - Drinking Water System Components - Health Effects.
- Q. PPI TR-4 - PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe.

#### 1.04 RESPONSIBILITY FOR MATERIALS:

- A. The Contractor shall be responsible for all material furnished by them, and shall replace at their own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all material and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work, or during the 1-year warrantee period.
- B. The Contractor shall be responsible for the safe storage of material furnished by them or to them and accepted by them and intended for the work, until it has been incorporated in the completed project. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.
- C. Pipe shall be carefully inspected for soundness before being installed in the trench. Rejected pipe and fittings shall be removed from the site immediately and permanently.

#### 1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.

## PART 2 - PRODUCTS

### 2.01 SANITARY SEWER PIPE:

- A. Main Line Pipe: The pipe used for sanitary sewer main lines shall be polyvinyl chloride (PVC) having a minimum cell classification of 12354-B as determined by ASTM D1784. The pipe shall be produced by a continuous extrusion process employing a prime grade of plasticized polyvinyl chloride. Grade used shall be highly resistant to hydrogen sulfide, sulfuric acid, gasoline, oil, detergents, and other chemicals commonly found in sewage and industrial wastes.
  - 1. PVC pipe shall have a minimum SDR of 35 and be manufactured in accordance to ASTM D3034.
  - 2. Pipe shall be bell and spigot type with rubber gasket type joints conforming to ASTM F477.
  - 3. All pipes shall comply with ASTM F794 and ASTM D2412.
  - 4. Pipe shall have self-extinguishing flammability characteristics.
  - 5. Nominal laying length of pipe shall not be less than 12-1/2 feet, except shorter lengths may be used adjacent to manholes and other appurtenances.
  - 6. Each length of pipe shall be marked with size, SDR, "Sewer Pipe", and code number.
- B. Service Line Pipe: The pipe and fittings used for sanitary sewer services shall be Schedule 40 PVC per ASTM D2665.

1. All service pipes shall be 4" diameter, unless 6" is required by the construction plans.
  2. Appropriate connections/gaskets must be used on both ends of the service line so all connections are water tight and fit properly.
- C. Service Line Cleanout: A cleanout shall be installed on all sanitary service lines.
1. Cleanouts shall be Schedule 40 PVC of the same size as the service line.
  2. Covers for 4 inch cleanouts in hard surfaced areas shall consist of a 10 inch long slip-type valve box top section with a lid marked "SEWER". The valve box top section shall have a concrete collar installed around it in accordance with 331110 - Water Valves and Valve Boxes.
  3. Cleanouts shall be installed at branch connections, at every change in alignment, and at least every 100 feet in straight runs.
  4. All cleanouts shall have a minimum 12 inch length section of #4 reinforcing steel bar placed beside the cleanout for locating purposes.
- D. Service Wyes: All service tees shall be manufactured of the same material as the main line pipe.
1. The connection to an unlined main shall be made by a 45-degree wye.
  2. The service connection shall be in-line type for new construction, or a saddle type for existing installations, as approved by Architect/Engineer.
  3. When the main to be tapped has been previously lined, the Inserta Tee ® Fatboy fitting shall be used for the tap.
- E. Service Tracer Wire: Tracer wire shall be installed along all sanitary service lines per Section 312316.13 - Trenching.
- F. Manholes: Manholes shall be constructed of precast reinforced concrete in accordance with Section 330500 - Manholes.
- G. Plugs and Markers: Sanitary sewer service lines shall be capped or plugged if not put into service immediately.
1. The cap or plug shall be gasketed, watertight injection molded PVC caps or plugs compatible for use with gasketed sanitary sewer pipe.
  2. The end of the sanitary sewer services shall be marked with a 2"x4" wooden stud, 4 feet in length (minimum).
    - a. The 2"x4" wooden stud shall be located immediately adjacent to the plug or cap, painted green and shall have a 2 foot piece of #4 reinforcing steel bar placed next to the wooden stud for future locating purposes.
    - b. The #4 bar shall not extend above finished grade and the wooden stud shall only extend 1-foot above finished grade.
- H. Couplings: Connections from the existing sanitary sewer main to the new sanitary sewer main shall be a double band reinforced Fernco coupling, or approved equal.
1. Couplings for service lines of dissimilar materials shall be rubber or elastomeric sleeve and stainless steel band assembly fabricated to match outside diameters of pipes to be joined.
  2. Sleeves: Sleeves shall be per the pipe material being connected.
    - a. Vitrified Clay Pipe: Coupling sleeves shall be rubber per ASTM C425.
    - b. Plastic Pipe: Coupling sleeves shall be elastomeric per ASTM F477.
    - c. Sleeves for dissimilar, or other pipe materials, shall be compatible with pipe materials being joined.
  3. Couplings shall be Indiana Seal Shear Guard, or approved equal.
- I. Future stub-outs: Any future stub-out for a newly installed sanitary sewer main shall end with a clean out of the same size diameter as the mainline pipe or with a manhole.

J. Force Mains:

1. PVC Pipe: The pipe and fittings used for force mains shall be SDR 18 conforming to the requirements of ASTM D2241 and ASTM D1784 with rubber gaskets conforming to ASTM D1869 and F477.
  - a. Force main cleanouts shall be installed at the locations identified in the construction plans.
  - b. Cleanouts shall be the same size as the main line and of the same material.
  - c. Gate valves associated with force main cleanouts shall meet the requirements of Section 331110 - Water Valves and Valve Boxes.
2. HDPE Pipe: Black polyethylene material used for the manufacture of polyethylene used for the manufacture of polyethylene pipe and fittings shall be PE 3408 high density polyethylene meeting ASTM D3350 cell classification 345464C and the name of the pipe and fitting manufacturer shall be listed in PPI TR-4 with a standards grade HDB rating of 1,600 psi at 73°F.
  - a. The material shall be listed and approved for potable water in accordance with NSF 61.
  - b. HDPE pipe shall be manufactured to the requirements of ASTM F714 and AWWA C906. Pipe shall be DR-11.
  - c. HDPE pipe shall have 3 equally spaced pairs of longitudinal green color stripes or the pipe specification in green text co extruded into the pipe outside surface or the pipe specification printed in green text on the outside surface of the pipe.

2.02 WARNING TAPE AND TRACER WIRE:

- A. Detectable Warning Tape: Detectable Warning Tape shall be provided in accordance with Section 312316.13 - Trenching.
  1. Warning tape shall be green and labeled "CAUTION: SEWER LINE BURIED BELOW".
- B. Tracer Wire: Tracer wire shall be provided in accordance with Section 312316.13 - Trenching.

- 2.03 Utility Markers shall be Carsonite Utility Markers or Architect/Engineer approved equal. Markers shall be made of a green composite material and be 3-3/4 inch wide and 66 inch long. The utility marker shall be designed in accordance with the City standard details.

PART 3 - EXECUTION

3.01 PIPE INSTALLATION:

- A. Excavation and Backfill: Excavation, backfill and compaction shall conform to the applicable portions of Section 312316.13 - Trenching. Bedding pertains to both mains and service lines.
- B. Handling of Pipe: All pipe furnished by the Contractor shall be delivered and distributed at the site by the Contractor.
  1. Pipe and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped.
  2. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. Metal bands around pipe bundles shall be cut with a handheld snips.
  3. Pipe shall be so handled that the pipe, coating and lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the Architect/Engineer.
- C. Laying Pipe: All pipe shall be laid and maintained to the required lines and grades with fittings and tees installed at the required locations.

1. Pipe runs shall be installed where indicated if the piping is dimensioned.
    - a. Where piping is not dimensioned, the Contractor shall install the pipe as close as possible to the locations indicated, as approved by the Architect/Engineer.
  2. Wherever obstructions not shown in the Plans are encountered during the progress of the Work and interfere to such an extent that an alteration in the plan is required, the Architect/Engineer shall have the authority to change the Plans and order a deviation from the line and grade or arrange for the removal, relocation or reconstruction of the obstructions.
  3. Proper implements, tools, and facilities satisfactory to the Architect/Engineer shall be provided and used by the Contractor for the safe and convenient execution of the Work.
    - a. All pipe and fittings shall be carefully lowered into the trench piece by piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage to pipe.
    - b. Under no circumstances shall materials be dropped or dumped into position.
  4. Water shall not be allowed to accumulate in the trench during the laying of the pipe or the initial backfill operations.
    - a. The trench shall be dewatered in accordance with Section 312316.13 - Trenching.
    - b. The Contractor shall take all necessary precautions to prevent surface water from entering the sewer trench.
    - c. The cost of dewatering the trench shall be included in the Contractor's bid.
  5. Pipe shall be protected from lateral displacement by means of pipe embedment material installed in accordance with Section 312316.13 - Trenching.
    - a. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.
  6. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line.
    - a. If the pipe laying crew cannot put the pipe into the trench and in place without getting earth into it, the Architect/Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe.
    - b. Before final acceptance the Contractor shall remove from the pipe any foreign material which may have gotten into the line.
  7. During laying operations, no debris, tools, clothing or other material shall be placed in the pipe.
  8. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Architect/Engineer.
  9. Unless otherwise approved by the Architect/Engineer, the laying of pipe shall begin at the lowest point.
  10. For bell and spigot pipe, the pipe shall be installed so that the spigot ends point in the direction of flow.
  11. Preparatory to making the joints, the pipe grade and alignment shall be checked and all dirt or other foreign matter shall be removed from the bell or coupling.
  12. Sanitary sewer mains shall be installed with a laser and under the full time supervision of the Architect/Engineer.
  13. Contractor shall verify if each sanitary sewer service line is in use by flowing water down the line or otherwise testing the service line.
- D. Rubber Gasketed Joints: Jointing of pipe made with a rubber gasket joint shall be made as recommended by the manufacturer.
1. The rubber gasket and gasket seat inside the bell shall be wiped clean with a cloth.
  2. A thin film of lubricant, furnished with the pipe, shall be applied to the inside surface of the gasket.

3. The plain end of the adjoining pipe shall be wiped clean and inserted into the bell a sufficient distance to make contact with the gasket. The plain end shall then be forced "home" by the use of a crow bar, fork tool, or jack assembly.
  4. The gasket joint assembly shall be made in strict accordance with the manufacturer's recommendations.
- E. Service Line Tap on a Lined Main: The area of the tap shall be prepared by breaking away the outer, deteriorated pipe by hand with a chisel, a diameter of 2 inches larger than the fitting diameter.
1. Once exposed, the pipe liner shall be cleaned, and the appropriate Inserta Tee hole saw shall be used to drill the hole for the fitting. The Inserta Tee Fatboy fitting shall be installed per the manufacturer's instructions supplied.
  2. The area of the tap shall then be restored by removing any loose pieces of the outer pipe and, when necessary to protect the pipe liner, encasing the cut-away area with concrete.
- F. Sewer Testing:
1. General: The Contractor shall provide all equipment, materials, and do all work necessary to conduct tests to determine any leakage on the installed gravity sewer and also to determine and correct any structural problems with the installed sewer.
    - a. The tests to be required before acceptance shall be as specified in this section. All tests shall be performed in the presence of the Architect/Engineer. The Architect/Engineer shall be notified at least 48 hours in advance of all testing.
    - b. When work consists of installation or replacement of sanitary sewer mains with multiple active service lines where exfiltration or air testing is not practical, the Contractor shall provide a video inspection of all service lines from the cleanout to the main (or point of connection to existing service line to the main, whichever distance is greater).
      - 1) The Contractor shall provide all labor, materials, equipment and bear the cost for the service line video inspections.
    - c. The Contractor shall repair areas that do not comply with the Specifications and revideo these areas until all corrections are satisfactorily completed.
  2. Water Test
    - a. When groundwater is a minimum of 2 feet above the sewer line, tests shall be made by sealing off the section of lines between manholes and measuring the infiltration by collecting or pumping the discharge into barrels or other approved methods. Tests shall be continued over a period of at least 4 hours for each section tested. Sufficient time shall be allowed to soak lines and manholes in advance of performing tests.
    - b. When groundwater is not above the pipe testing shall be as follows:
      - 1) On flat slopes where the depth over the centerline of the pipe in the lower manhole of the section being tested will not be more than 10 feet, the upper manhole shall be filled to a depth of two feet over the top of the pipe and the lower manhole blocked. The leakage shall be measured by checking the drop in water level in the manhole over a period of 4 hours. When the above conditions cannot be met, the Architect/Engineer may order the Contractor to test the line in sections between the manholes.
      - 2) The maximum allowable infiltration or exfiltration including manholes shall not exceed 200 gallons per day per mile of sewer per inch of pipe diameter. This does not preclude the fact that obvious and concentrated leaks such as open joints, pinched gaskets, cracked barrels, cracked bells, etc. will not be allowed. Contractor shall make repairs on concentrated leaks as necessary to reduce infiltration or exfiltration leakage below the specified rate.
  3. Low Pressure Air Test (Alternate): A low pressure air test may be used, if the Contractor's proposed procedures are approved by the Architect/Engineer.



- a. The test methods and evaluation of results shall comply fully with ASTM C828 for Vitrified Clay Pipe, ASTM C 1103 for concrete pipe, and ASTM F1417 for Plastic Pipe.
- b. Equipment required includes: two air-tight plugs, braces for plugs, compressor, air supply hose, throttling valve on air supply line, air bleed valve, high pressure shut-off valve on compressor, pressure gauge with isolation cock.
4. Infiltration: If at any time prior to expiration of the one year correction period, there is any infiltration, the Contractor shall locate the leaks and make repairs as necessary to control the infiltration.
5. Alignment and grade: A lamp test shall be performed to verify alignment between manholes. All sections of the sewer are to be within 3/4 inch of specified horizontal alignment and 1/4-inch of the specified vertical grade.
6. Vacuum testing of manholes: When manholes are being constructed in areas where groundwater is elevated or anticipated to be elevated above the manhole base, The Contractor shall conduct a vacuum test on each manhole, or conduct a leakage test in conjunction with the test on the sewer.
  - a. Test shall be conducted in accordance with ASTM C1244/C1244M. It is recommended the vacuum test be completed prior to backfilling around the manhole.
  - b. All lift holes shall be plugged with nonshrink mortar.
  - c. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
  - d. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
  - e. A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 inches of mercury.
  - f. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets, or exceeds, the values indicated in Table 1.
  - g. If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.
  - h. Testing of manholes may be waived at the discretion of the Architect/Engineer and City for situations in which live flows prevent such testing.

| TABLE 1 - Minimum Test Times for Various Manhole Diameters |    |    |    |    |    |    |    |     |     |
|------------------------------------------------------------|----|----|----|----|----|----|----|-----|-----|
| Depth<br>(ft)                                              | 30 | 33 | 36 | 42 | 48 | 54 | 60 | 66  | 72  |
| Time (sec)                                                 |    |    |    |    |    |    |    |     |     |
| 8                                                          | 11 | 12 | 14 | 17 | 20 | 23 | 26 | 29  | 33  |
| 10                                                         | 14 | 14 | 18 | 21 | 25 | 29 | 33 | 36  | 41  |
| 12                                                         | 17 | 18 | 21 | 25 | 30 | 35 | 39 | 43  | 49  |
| 14                                                         | 20 | 21 | 25 | 30 | 35 | 41 | 46 | 51  | 57  |
| 16                                                         | 22 | 24 | 39 | 34 | 40 | 46 | 52 | 58  | 67  |
| 18                                                         | 25 | 27 | 32 | 38 | 45 | 52 | 59 | 65  | 73  |
| 20                                                         | 28 | 30 | 35 | 42 | 50 | 53 | 65 | 72  | 81  |
| 22                                                         | 31 | 33 | 39 | 46 | 55 | 64 | 72 | 79  | 89  |
| 24                                                         | 33 | 36 | 42 | 51 | 59 | 64 | 78 | 87  | 97  |
| 26                                                         | 36 | 39 | 46 | 55 | 64 | 75 | 85 | 94  | 105 |
| 28                                                         | 39 | 42 | 49 | 59 | 69 | 81 | 91 | 101 | 113 |
| 30                                                         | 42 | 45 | 53 | 63 | 74 | 87 | 98 | 108 | 121 |

7. Video Inspection: The sanitary sewer main shall be cleaned by the Contractor to the satisfaction of the Architect/Engineer if gravel, sediment, or other material has entered the sanitary sewer.
- a. This shall be done prior to testing, final inspection, and acceptance. It shall additionally be performed prior to street paving. The Contractor shall repair areas that do not comply with the Specifications.
  - b. The City will perform a video inspection of the sewer main (8" or larger) before acceptance. Video inspections will be made after placement of backfill and crushed base surfacing over the sewer and after the cleaning of the line and the lamp and mandrel testing have passed and approved by the Architect/Engineer.
  - c. A smooth dry surface shall be prepared by the Contractor in order for the camera to make it to each manhole.
  - d. Any low spots in the sewer pipe, which allows water to pond to a depth of 1/2-inch or greater, shall constitute a failure of the test. Failure of the camera to make it to each manhole due to obstructions, mud, low spots or other defects shall also constitute a failure of the test.
    - 1) All low spots, which fail the video test, shall be brought to grade.
    - 2) Any spots showing infiltration, exfiltration, rolled gaskets, or other construction defects shall also be repaired.
    - 3) All repairs shall be made at no cost to the Owner. Video inspection is to be repeated after the corrections are made.
  - e. Any time of the City's personnel associated with video inspection of the sanitary sewer, other than for the successful video inspection, will be invoiced to the Contractor by the City.
    - 1) When the City's staff arrives at the scheduled time to perform the inspection, if the Contractor has not made the preparations to allow the inspection within 15 minutes of the City's arrival, City's staff will leave and the inspection will be rescheduled through the Architect/Engineer, and a two-hour charge for City's personnel's time will be charged to the Contractor. All charges will use rates established by the City's utility labor and equipment rates.
    - 2) The City may also perform a video of the sewer near the end of the warranty period.
  - f. The video inspection shall be done in the presence of the Architect/Engineer. All tapes of the inspection shall become the property of the City.
  - g. Where replacement sewer follows the alignment of the existing sanitary sewers, service lines will need to be reconnected as the new sewer is installed. This will prevent the use of a pressure test. The video inspection of the sewer mains may also be used in lieu of the pressure test to identify any infiltration or exfiltration, as approved by the Architect/Engineer.
  - h. All existing sanitary sewer mains may be videoed by the City prior to construction and after completion of construction. The Contractor will be responsible for repairs, to the satisfaction of the Architect/Engineer, and for any damage to existing sewer lines as a result of construction of the Project.
  - i. New service lines will also be videoed by the Contractor. The Contractor is responsible for correcting any problems found.
8. Deflection: A deflection test shall be conducted by pulling an approved solid pointed mandrel (Go-No Go device) through the installed sewer pipe prior to the City cameraing the sewer main. The diameter of the mandrel shall be 95% of the pipe diameter. Deflection testing shall be conducted on a manhole-to-manhole basis. Failure to pass the mandrel through a reach of sewer pipe shall constitute a failure of the test and will require the Contractor, at his expense, to locate and repair the portion of sewer pipe that has failed. Once repaired, that portion of pipe shall be deflection tested again.
- G. Separation with Water Mains: The sewer shall be laid at least 10 feet horizontally from any existing or proposed water main. This distance shall be measured from edge of pipe to edge of-pipe.

1. At crossings the sewer shall be installed to provide a minimum vertical separation of 18 inches between the outside of the water main and the outside of the sewer pipe. This shall be the case when the sewer is either above or below the water main.
    - a. At the crossing, sewer joints are to be arranged so that they are as far as possible from the water main.
  2. At all crossings, pipe and backfill shall be properly installed to support the pipes.
    - a. When required, flowable fill is to be used at the crossing to fully support both pipes. The material is to be tamped and rodded to fill all voids adjacent to and below both pipes and to compact the fill material.
  3. Where the 10 foot horizontal separation cannot be maintained, this separation may be reduced to 5 feet, provided the bottom of the water main is at least 18 inches higher than the top of the sewer.
  4. Where the requirements for the bottom of the water line to be at least 18 inches higher than the top of the sewer cannot be met, the installation is allowable under one of the following options:
    - a. The proposed water line is lowered to at least 3 feet below the invert of the sewer pipe when measured from the top of the waterline pipe.
    - b. The sewer may be encased in a minimum of 6 inches of flowable fill around the pipe, extended out a distance of 10 feet on both sides of the crossing. The pipe shall be placed on blocks to allow the lean concrete under the pipe. The pipe shall be fully supported, and stakes used to hold it from lateral movement, to ensure it is not displaced during the placement of the flowable fill.
      - 1) The new section of sewer shall be pressure tested at 10 feet of head with allowable leakage determined by the equation in Section 331210 - Disinfecting Water Piping Systems. In addition to meeting this leakage limitation, there can be no visible leakage at joints in the sewer within 10 feet of the water main.
    - c. Place the sanitary sewer in a separate conduit (pipe) for a distance of 10 feet on either side of the crossing.
  5. Where unusual situations are encountered that makes it impossible to follow the requirements of this section a different approach might be required. That approach is to be designed on a case by case basis with the design for that particular separation approved by the City and the Wyoming Department of Environmental Quality. The Contractor shall be paid for this particular work as required as a changed site condition.
- H. Separation of Water and Sewer Services: Water and sanitary sewer services shall be installed per Wyoming Department of Environmental Quality (WDEQ) regulations and the latest edition of the International Plumbing Code (IPC) and as amended by the City. In cases where the WDEQ and IPC regulations conflict, the IPC regulations shall govern.
- I. Prior to final acceptance of the sewers, the Contractor must thoroughly flush and clean lines of any construction debris. The Contractor is responsible for collecting any debris in these lines and preventing it from passing on downstream into the City sewer system. Any damages associated with the construction debris to any portion of the City's sewer system (including the wastewater treatment plant), shall be paid for in full by the Contractor.
- J. Support of Sewer Crossings: Where a new pipeline crosses under an existing sanitary sewer main or sewer service flowable fill shall be placed between the two pipes to support the upper pipe. Flowable Fill must extend fully between the lower pipeline and the upper pipe.

END OF SECTION 333100

## SECTION 334100 - SUBDRAINAGE

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Building Perimeter and Retaining Wall Drainage Systems.
- B. Filter aggregate and fabric and bedding.

#### 1.02 RELATED REQUIREMENTS

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report; bore hole locations, findings of subsurface materials, and recommendations.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 312500 - Engineering Fabric
- D. Section 312316 - Excavation
- E. Section 312316.13 - Trenching
- F. Section 312323 - Fill

#### 1.03 REFERENCE STANDARDS

- A. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe.
- B. ASTM C4 - Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile.
- C. ASTM C412 - Standard Specification for Concrete Drain Tile.
- D. ASTM C412M - Standard Specification for Concrete Drain Tile (Metric).
- E. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics.
- F. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics.
- G. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- H. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus.

#### 1.04 SUBMITTALS

- A. Submittals are required for all materials and shall be in accordance with these Specifications.
- B. Product Data: Provide data on pipe drainage products, pipe accessories, and drain fill aggregate.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.

## PART 2 PRODUCTS

### 2.01 PIPE MATERIALS

- A. Drain pipe shall be: Perforated corrugated polyethylene, complying with AASHTO M 252 with required fittings being Contech A-2000, ADS N-12 pipe, or equal products approved by the Architect/Engineer. Size and locations shall be per the Construction Plans.
- B. Unperforated pipes shall be used through all wall penetrations for the subdrainage system; or as specified in the Plans.

### 2.02 AGGREGATE AND BEDDING

- A. Filter Aggregate and Bedding Material: Gravel as specified in Section 321123 - Aggregate Base Courses.

### 2.03 ACCESSORIES

- A. Pipe Couplings: Solid plastic per pipe manufacturer requirements.
- B. Geotextile Fabric: As specified in Section 312500 - Engineering Fabric.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on the Plans.

### 3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with material approved by the geotechnical engineer.
- B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

### 3.03 INSTALLATION

- A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.
- B. Place drainage pipe on compacted fill material approved by the geotechnical engineer.
- C. Lay pipe to slope gradients shown on the Plans; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Loosely butt pipe ends. Place joint cover strip 12 inches wide, around pipe diameter centered over joint.
- E. Place pipe with perforations facing down unless otherwise required by pipe manufacturer. Mechanically join pipe ends.
- F. Install pipe couplings.
- G. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches or as shown on the Plans.

- H. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.
- I. Place aggregate in maximum 6 inch lifts, consolidating each lift.
- J. Refer to Section 312323 for compaction requirements. Do not displace or damage pipe when compacting.
- K. Place geotechnical engineer approved fill over drainage pipe aggregate cover and compact.
- L. Connect to storm sewer system with unperforated pipe as shown on the Plans.

#### 3.04 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Field inspection and testing.
- B. Request inspection prior to placing aggregate cover over pipe.

#### 3.05 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION 334100

## SECTION 334200 - STORM SEWER PIPING

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered includes furnishing and installing all storm sewer piping on the project.

#### 1.02 RELATED WORK:

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312110 - Dewatering
- C. Section 312316.13 - Trenching
- D. Section 330200 - Underground Utilities
- E. Section 330500 - Manholes
- F. Section 334250 - Storm Sewer Inlets

#### 1.03 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
- B. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- C. ASTM D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- D. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- E. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- F. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- G. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- H. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- I. ASTM F794 - Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- J. ASTM F949 - Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings.
- K. ASTM F2306 - Standard Specification for 300 mm to 1500 mm [12 in. to 60 in.] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Non-Pressure Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
- L. ASTM F2648 - Standard Specification for 50 mm to 1500 mm [2 in. to 60 in.] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

- M. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm).
- N. WYDOT Standard Specifications for Road and bridge Construction - Wyoming Department of Transportation Standard Specifications for Road and Bridge Construction.

#### 1.04 RESPONSIBILITY FOR MATERIAL:

- A. The Contractor shall be responsible for all such material furnished by them and shall replace, at their own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work or during the one-year warranty period.
- B. The Contractor shall be responsible for the safe storage of material furnished by them or to them and accepted by them and intended for the work. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.
- C. Pipe shall be carefully inspected for soundness before being installed in the trench. Rejected pipe and fittings shall be removed from the site immediately and permanently.

#### 1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.
- B. Certification by Manufacturer:
  - 1. Contractor shall furnish certification by the manufacturer of the pipe to be furnished on the Project, certifying that the pipe complies with the applicable specifications. Required certification shall accompany each delivery of material.
  - 2. All pipe shall be clearly marked with type, class and or, thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.
  - 3. Type of joint, class, thickness designation, casting, lining, marking, testing, etc., shall be specified.

## PART 2 - PRODUCTS

### 2.01 PIPE & FITTINGS

- A. PVC: PVC pipe shall meet the requirements of ASTM F794 and ASTM F949 for corrugated pipe. The pipe shall have a smooth interior and ribbed or corrugated exterior.
  - 1. The pipe stiffness shall be a minimum of 46 psi when tested at 5% deflection in accordance with ASTM D2412.
  - 2. The pipe shall be ETI Ultra-Corr, ETI Ultra-Rib, Contech A-2000 or approved equal.
  - 3. Any wyes or connections shall be provided by the pipe manufacturer and shall be fully compatible with the pipe ribs.
  - 4. Manhole connections shall include an entry piece provided by the pipe manufacturer.
  - 5. Installation of the PVC pipe shall follow manufacturer's recommendations.
  - 6. PVC pipe shall be manufactured of PVC plastic having a minimum cell classification of 12354-B as determined by ASTM D1784. All PVC pipe shall have a minimum SDR of 26 and be manufactured in accordance to ASTM D3034 ASTM D3034. SDR 35 may be substituted for SDR 26 if load conditions allow its use, and if approved by the Architect/Engineer.
  - 7. Pipe shall be bell and spigot type with rubber gasket type joints conforming to ASTM F477. The pipe shall comply with ASTM F794 and ASTM D2412.



8. For locations in which the storm sewer pipe has limited cover over it, PVC pipe conforming to AWWA C900 may be substituted for the thinner-walled PVC pipe. Either PVC push-on or fusible pipe may be used. If fusible PVC pipe is used, the exposed beads of the interior fuse welds shall be removed.
- B. HDPE: High Density Polyethylene High Density Polyethylene (HDPE)
1. Fused Joint: Fused joint pipe shall be Plexco Bluestripe or Architect/Engineer approved equal. Pipe shall be ductile iron pipe size. Wall thickness shall be based upon depth of cover over the pipe.
    - a. Materials used for the manufacturing of polyethylene pipe shall be PE3408 High Density Polypropylene (HDPE) meeting the ASTM D3350 cell classification of 345434C. The material shall have a minimum Hydrostatic Design Basis (HDB) of 1600 psi at 75°F when tested in accordance with PPI TR-3 and shall be listed in the name of the pipe and fitting manufacturer in PPI TR-4. The Manufacturer shall certify that the materials used to manufacture pipe and fittings meet the requirements of this specification.
  2. Bell and Spigot: High Density Polypropylene pipe and fittings 4 inch through 60 inch diameter storm pipes shall have a smooth interior and annular exterior corrugations and shall conform to ASTM F2648.
    - a. Material for pipe production shall be an engineered compound of virgin and recycled high-density polyethylene (HDPE) conforming with the minimum requirements of cell classification 424420C (ESCR Test Condition B) for 4 inch through 10 inch diameters, and 435420C (ESCR Test Condition B) for 12 inch through 60 inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%.
      - b. Watertight Joints:
        - 1) Watertight Joints: Pipe shall be joined using a bell and spigot joint also meeting ASTM F2648. Unless noted otherwise in the construction plans, the joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. Pipe 12 inch through 60 inch diameter shall have an exterior bell wrap installed by the manufacturer.
        - 2) To ensure watertightness, field performance verification may be accomplished by testing in accordance with ASTM D2487. Appropriate safety precautions must be used when field testing any pipe material. Acceptable leakage rates shall be per the recommendation of the pipe manufacturer.
        - 3) HDPE watertight fittings shall conform to ASTM F2306. Bell and spigot connection shall utilize a welded bell and valley or saddle gasket meeting the watertight joint performance requirements of ASTM F2306.
      - c. Soil-Tight Joints:
        - 1) Where soil-tight joints are called out in the construction plans pipe shall be joined using a bell and spigot joint also meeting ASTM F2648. The joint shall be soil-tight and gaskets for pipe diameters 12 inch through 20 inch shall meet the requirements of ASTM F477. For diameters 4 inch through 10 inch, the joint shall be soil-tight using an engaging dimple connection. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.
        - 2) HDPE soil-tight fittings shall conform to ASTM F2306. Bell and spigot connections shall utilize a welded bell and valley or saddle gasket meeting the soil-tight performance requirements of ASTM F2306.

- d. Any wye or other fittings/connections shall be provided by the pipe manufacturer and shall be fully compatible with the pipe corrugations.
- e. Installation of the pipe shall follow manufacturer's recommendations, including consideration for proper bedding of the pipe, as well as the minimum and maximum cover depths of the pipe. The brand and type of pipe and fittings shall be ADS N-12 HDPE, or Architect/Engineer approved equal.

## 2.02 REPLACEMENT PIPES:

- A. If any water mains, sanitary sewer mains, water service, or sanitary sewer service lines must be relocated or replaced due to the installation of the storm sewer pipe, the appropriate section of these specifications must be followed.

## 2.03 TRASH GUARDS:

- A. Metal fabricated trash guards shall be provided when specified. Trash guards shall meet the requirements of Section 619 (and associated subsections and details) of the WYDOT Standard Specifications for Road and bridge Construction with the following exceptions:
  - 1. Trash guards shall not be fabricated on site.
  - 2. Shop Drawings are required to be submitted for review and approval prior to fabrication.
  - 3. When required, the Owner will provide padlocks for the locking bar.

# PART 3 - EXECUTION

## 3.01 INSTALLATION

- A. Excavation and Backfill: Excavation, backfill and compaction for pipe shall conform to the applicable portions of Section 312316.13 - Trenching, including thoroughly compacting the bedding under the pipe haunches.
  - 1. Bedding must be placed to a density of 93% as determined by ASTM D698. Bell holes shall be provided in the trench bottom for the pipe. If the Contractor over excavates he shall compact material back, according to the bedding specifications to provide uniform support to the pipe. Bedding shall also comply with the manufacturer's requirements, if more stringent than the above.
- B. Handling of Pipe: All pipe furnished by the Contractor shall be delivered and distributed at the site by the Contractor.
  - 1. Pipe, fittings, and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skid ways shall not be skidded or rolled against pipe already on the ground.
  - 2. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be installed. All material shall be stored in a neat and orderly manner.
- C. Laying Pipe: All pipe shall be laid and maintained to the required lines and grades with fittings and tees installed at the required locations. Pipe runs shall be installed where indicated if the piping is dimensioned.
  - 1. Wherever obstructions not shown in the construction plans are encountered during the progress of the work and interfere to such an extent that an alteration in the plan is required, the Architect/Engineer shall have the authority to change the Plans and order a deviation from the line and grade or arrange for the removal, relocation or reconstruction of the obstructions.

2. Proper implements, tools, and facilities satisfactory to the Architect/Engineer shall be provided and used by the Contractor for the safe and convenient execution of the Work. All pipe and fittings shall be carefully lowered into the trench piece by piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage to pipe. Under no circumstances shall materials be dropped or dumped into position.
  3. Water shall not be allowed to accumulate in the trench during the laying of the pipe or the initial backfill operations. The trench shall be dewatered in accordance with Section 312316.13 - Trenching. The Contractor shall take all necessary precautions to prevent surface water from entering the storm sewer trench. The cost of dewatering the trench shall be included in the Contractor's bid.
  4. Pipe shall be protected from lateral displacement by means of bedding material installed as provided in Section 312316.13 - Trenching.
    - a. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.
  5. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed.
    - a. If the pipe laying crew cannot put the pipe into the trench and in placed without getting earth into it, the Architect/Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe.
    - b. Before final acceptance the Contractor shall remove from the pipe any foreign material, including dirt or sand, which may have gotten into the line.
  6. During laying operations, no debris, tools, clothing or other material shall be placed in the pipe. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug, or other means approved by the Architect/Engineer.
  7. At any time a RCP is saw cut, the steel reinforcement shall be cut flush with the end of the pipe.
  8. Unless otherwise approved by the Architect/Engineer, the laying of pipe shall begin at the lowest point.
  9. For bell and spigot type pipes, the pipe shall be installed so that the spigot ends point in the direction of flow.
  10. Preparatory to making the joints, the pipe grade and alignment shall be checked and all dirt or other foreign matter shall be removed from the bell or coupling.
- D. Pipe Deflection: Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane or avoid obstructions or plumb stems or where long-radius curves are permitted, the amount of deflection allowed shall not exceed that required for satisfactory jointing, requirements of the pipe manufacturer, and shall be approved by the Architect/Engineer.
- E. Rubber Gasketed Joints: Jointing of pipe made with a rubber gasketed joint shall be made as recommended by the manufacturer.
1. The rubber gasket and gasket seat inside the bell shall be wiped clean with a cloth.
  2. A thin film of lubricant, furnished with the pipe, shall be applied to the inside of the gasket.
  3. The plain end of the adjoining pipe shall be wiped clean and inserted into the bell a sufficient distance to make contact with the gasket. The plain end shall then be forced "home" by the use of a crow bar, fork tool or jack assembly.
  4. The pipe joints shall fit together tightly and properly.
    - a. Any displaced sealant shall be replaced.
    - b. Any broken joints or portions of joints shall be replaced if directed by the Architect/Engineer, or grouted to the Architect/Engineer's satisfaction.
    - c. Any loss of sealant shall be replaced or grouted to the Architect/Engineer's satisfaction.

F. Storm Drain Testing:

1. A leakage test of the storm sewer will not be required, however, any concentrated leaks such as open joints, pinched joint material, cracked barrels or bells, noticeable infiltration and exfiltration, etc., shall be repaired to the satisfaction of the Architect/Engineer.
2. Alignment and Grade: All sections of the storm pipe are to be within 1 inch of specified horizontal alignment and 1/2 inch of the specified vertical grade.
  - a. Water shall not pond in the storm sewer pipe more than 3/4 inch deep.
3. The storm sewer shall be cleaned by the Contractor to the satisfaction of the Architect/Engineer if gravel, sediment or other material has entered the storm sewer. This shall be done prior to videoing, final inspection, and acceptance. It also shall be performed prior to paving operations.
4. After the trench has been backfilled, a light test shall be made between drainage structures (manholes, inlets, etc.) to check alignment and grade for displacement of pipe. The completed pipeline shall be such that a true circle of light can be seen from one structure to the next. If alignment or grade is other than specified and displacement of pipe is found, the Contractor shall remedy such defects at their own expense.

G. Separation with Water Mains: The storm pipe shall be laid at least 10 feet horizontally from any existing or proposed water main. This distance shall be measured from edge of pipe to edge of pipe.

1. At crossings the storm sewer shall be installed to provide a minimum vertical separation of 18 inches between the outside of the water main and the outside of the storm pipe.
  - a. This shall be the case when the storm pipe is either above or below the water main.
  - b. At the crossing, storm pipe joints are to be arranged so that they are as far as possible from the water main.
2. At all crossings, pipe and backfill shall be properly installed to support the pipes.
  - a. When required, flowable fill is to be used at the crossing to fully support both pipes. The material is to be tamped and rodded to fill all voids adjacent to and below both pipes and to compact the fill material.
3. Where the 10 foot horizontal separation cannot be maintained, this separation may be reduced to 5 feet provided the bottom of the water main is at least 18 inches higher than the top of the storm sewer.
4. Where the requirements for the bottom of the water line to be at least 18 inches higher than the top of the storm sewer cannot be met, a different approach might be required. That approach is to be designed on a case-by-case basis with the design for that particular separation approved by the City and the Wyoming Department of Environmental Quality.

H. Manholes: Shall be constructed per Section 330500 - Manholes.

1. Storm sewer pipes shall penetrate into the manholes no more than 1 inch as measured at the side of the pipe.
2. The space between the manhole and the pipe shall be grouted watertight from both the inside and outside.
  - a. Grouting on the inside shall result in a smooth surface between the pipe and the manhole wall, and the pipe and the manhole invert.

I. Connections: Make connections to existing storm sewer piping and underground manholes.

1. Branch Connections Using Wye Fitting: Use commercially manufactured wye fittings for piping branch connections.
  - a. Remove section of existing pipe; connect wye fitting onto existing piping and encase entire wye fitting, plus 6-inch overlap with concrete except when concrete is not required by the fitting manufacturer installation instructions.

2. Branch Connection from Side (4 inch to 20 inch): Remove section of existing pipe, install wye fitting into existing piping and encase entire wye with not less than 6 inches of concrete except when concrete is not required by the fitting manufacturer installation instructions.
3. Branch Connection from Side (21 inch and larger): Connection to pipe, manhole, or other underground structure shall be made by cutting into the existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around the entering connection except when concrete is not required by the fitting manufacturer installation instructions.
  - a. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated.
  - b. Outside of pipe, manhole, or structure wall should be encased with 6 inches of concrete for a minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

END OF SECTION 334200

## SECTION 334210 - CULVERTS

### PART I - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work covered includes the furnishing and installation of pipe culvert, connecting bands, and appurtenances that are required to replace damaged sections or install new culvert sections as shown in the construction plans.

#### 1.02 RELATED WORK:

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report; bore hole locations and findings of subsurface materials.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 312110 - Dewatering
- D. Section 312201 - Grading
- E. Section 312316.13 - Trenching
- F. Section 330200 - Underground Utilities
- G. Section 340100 - Temporary Traffic Control

#### 1.03 REFERENCE STANDARDS

- A. AASHTO M 36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
- B. AASHTO M 196 - Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
- C. AASHTO M 197 - Standard Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe.
- D. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).

#### 1.04 RESPONSIBILITY FOR MATERIAL:

- A. The Contractor shall be responsible for all such material furnished by him/her and shall replace, at his/her own expense, all such material found defective in manufacture, or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the work, or during the one-year correction period.
- B. The Contractor shall be responsible for the safe storage of material furnished by him/her or to him/her and accepted by him/her and intended for the work. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Corrugated Metal Pipe: Corrugated metal pipe (CMP) shall conform to the requirements of the specifications AASHTO M 36, AASHTO M 196, or AASHTO M 197 .
  - 1. Steel pipe shall be galvanized and have a minimum gauge of 12 and shall be polymer coated.
- B. Flared Ends and Connecting Bands
  - 1. Flared ends to be used on the CMP and HDPE pipe shall be fabricated from galvanized sheet steel meeting the applicable requirements of AASHTO M 36.
    - a. Connecting bands to be used on the CMP and HDPE pipe shall be fabricated from galvanized sheet steel meeting the applicable requirements of AASHTO M 36.
  - 2. Flared ends to be used on concrete pipe shall be precast conforming to ASTM C76.
- C. Trash Guards: Trash guards shall be installed on pipe flared ends where specified and further detailed in the construction plans.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Excavation, backfill and compaction for the pipe shall conform to the applicable portions of Section 312316.13 - Trenching.
- B. In locations shown in the construction plans, or as directed by the Architect/Engineer, the Contractor shall remove the existing culvert, connecting bands, headwalls, cutoff walls, flared ends and all appurtenances to the limits required. In some cases this will require saw cutting the existing culvert at the edge of the excavation and upon completion of pipeline installation, backfill and reconnect with new materials to replace the damaged culvert.
- C. New or proposed culverts shall be constructed with new pipe materials to the lines and grades shown in the construction plans.
- D. The completed channel bottom shall be firm for its full length and width and where required, the channel shall have a longitudinal camber. The amount of camber shall be varied to suit height of fill and supporting soil, but in no case shall the camber create a reversal of the pipe gradient.
- E. Where conduits are placed in embankment fill, the excavation shall be made after the embankment has been completed to the specified height above the designed grade for those conduits specified in the construction plans.
- F. Excavated material shall be stockpiled for use as backfill, incorporated into other portions of work, or wasted as directed by the Architect/Engineer. Material to be used in the backfill of the pipe shall be stockpiled a minimum of two feet from the edge of the trench.
- G. Backfill material placed under, adjacent to, and over the pipe shall be fine, readily compactible, job excavated soil, or granular fill material. Backfill material shall not contain frozen lumps, organics, highly plastic clay, or large stones.

- H. Backfill shall be placed in compactible layers of approximately eight inches loose measurement, and each layer compacted to 93% of optimum dry unit weight in accordance with ASTM D698 and within +/-2% of the moisture content.
- I. Backfill adjacent to or over pipe culverts shall be brought up simultaneously on both sides of the pipe to avoid lateral displacement. Backfill under the haunches of the pipe shall be tamped or rammed into place between the pipe and the channel bottom.
- J. Care shall be exercised during backfilling operations to prevent damage to the pipe, either through unequal pressure exerted on the sides or by backfill being dropped directly onto the pipe.
- K. Pipe shall be inspected before any backfill is placed. Any pipe found to be out of alignment, unduly settled, or damaged shall be taken up and relaid or replaced.
- L. Flexible pipes shall be firmly jointed by coupling bands. The pipe installation shall begin at the downstream end of the line. The lower half of the pipe shall be in contact with the shaped trench bottom throughout its entire length.
- M. The outside circumferential laps of flexible pipe shall be placed facing upstream. The pipe shall be placed with longitudinal laps or seams at the sides.

END OF SECTION 334210



## SECTION 334250 - STORM SEWER INLETS

### PART 1 - GENERAL

#### 1.01 WORK INCLUDED:

- A. The work consists of furnishing and installing all storm drain inlets and accessories at locations as specified herein and indicated in the construction plans.

#### 1.02 RELATED WORK:

- A. Document Revised Subsurface Exploration and Geotechnical Report Campbell County High School (Issued November 17, 2025): Geotechnical report; bore hole locations, findings of subsurface materials, and recommendations.
- B. City of Gillette Standard Construction Specifications (2025)
- C. Section 033100 - Site Concrete Work
- D. Section 312110 - Dewatering
- E. Section 312316.13 - Trenching
- F. Section 330200 - Underground Utilities
- G. Section 330500 - Manholes
- H. Section 330510 - Adjusting Existing Utility Structures
- I. Section 334200 - Storm Sewer Piping

#### 1.03 REFERENCE STANDARDS

- A. ASTM A536 - Standard Specification for Ductile Iron Castings.
- B. ASTM C150/C150M - Standard Specification for Portland Cement.
- C. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
- D. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- E. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
- F. ASTM C1433 - Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.
- G. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- H. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- I. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

#### 1.04 RESPONSIBILITY FOR MATERIAL:

- A. The Contractor shall be responsible for all such material furnished by him/her and shall replace, at his/her own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work or during the one-year correction period.
- B. The Contractor shall be responsible for the safe storage of material furnished by him/her or to him/her and accepted by him/her and intended for the work. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

1.05 SUBMITTALS:

- A. Submittals are required for all materials and shall be in accordance with these Specifications.

PART 2 - PRODUCTS

2.01 INLETS/CATCH BASINS:

A. Precast Concrete Drainage Inlets

- 1. Inlets/catch basins shall be constructed of precast reinforced concrete using Type II or I-IISR cement and Class B per 033100 - Site Concrete Work.
- 2. Reinforced concrete inlet/catch basin sections shall conform to the requirements of Standard Specifications for Precast Reinforced Concrete Box Sections, ASTM C1433.
- 3. The inlet/catch basin shall be monolithic with the base and shall be cast with provisions to allow knockouts.
- 4. Precast adjusting grade rings, set in full cement mortar bed shall be used for adjustment of the frame and cover to finish grade.
  - a. The grade rings shall meet the requirements of ASTM C478/C478M.
  - b. Mortar used to grout concrete grade rings shall be:
    - 1) Portland Cement: Type 1 per ASTM C150/C150M
    - 2) Hydrated Lime: Type S per ASTM C207
    - 3) Concrete sand (fine aggregate) which has been sieved through an 8-mesh screen
    - 4) Volumetric proportions: 1 part Portland cement, 1/2 part hydrated lime, and 3 parts sand
    - 5) Cement, lime and sand shall be thoroughly mixed dry and only enough water added to form a mortar of the proper consistency.
  - c. The maximum height limitation on grade rings shall be 8 inches.
  - d. All mortar shall be used within 40 minutes after mixing. Mortar, which has begun to take on initial set, shall be discarded and shall not be mixed with additional cement or new mortar.
- 5. Joints between precast inlet/catch basin wall sections shall be made with premolded plastic filler such as Rubber-Nek, as furnished by K.T. Snyder Company of Houston, Texas, or an approved equal.
  - a. Tylox SuperSeal rubber pipe gaskets as manufactured by Hamilton-Ken Mfg. Co., Kent, Ohio or O-ring gaskets which will meet the requirements of ASTM C443 will be accepted as equal to Rubber-Nek plastic joint filler.
  - b. Jointing shall be installed in strict accordance with the plastic filler or gasket manufacturer's recommendations.
- 6. The inlet/catch basin shall be free of fractures and surface roughness. The planes of the ends of the inlet/catch basin shall be perpendicular to their longitudinal axis, within the limits as specified in ASTM C478/C478M.
  - a. If necessary, inlet/catch basin sections may be repaired, if in the opinion of the Architect/Engineer the repairs are sound and properly finished and cured and the repaired inlet/catch basin sections conform to the requirements of the Specifications.

B. PVC Drainage Inlets

1. PVC surface drainage inlets shall be ADS Nyloplast, or Architect/Engineer approved equal, and shall include the drain basin type as indicated on the project drawings and specifications. Drain basins shall be manufactured from PVC pipe stock utilizing a thermoforming process to reform the pipe stock to the specified configuration or equivalent process approved by the Architect/Engineer. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. Joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. Raw material used to manufacture the PVC pipe stock for the manufacturing the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454 or equivalent material approved by the Architect/Engineer.

2.02 INLET/CATCH BASIN FRAMES AND COVERS:

A. Inlet/Catch Basin Frames and Covers for Precast Concrete Units

1. All cast iron inlet/catch basin frames shall be made of tough gray pig iron conforming to the requirements of ASTM C478 Class 35 and shall be free from cracks, swells, holes and cold shuts, and shall have a smooth finish.
  - a. Castings shall conform in all dimensions as provided in the construction plans.
  - b. Before leaving the foundry, all casting shall be thoroughly cleaned and subjected to a hammer test.
  - c. The inlet/catch basin frame and grate shall be:
    - 1) Curb Inlet (Type A): D&L I-3520 frame with a D&L I-3520 Type "L" (Vaned) grate, or approved equal.
      - a) Shall be adjustable to meet the curb height.
      - b) Shall have fish logo printed on curb box
    - 2) Area Inlet (Type B): D&L A-1071 ring with C1043 cover, or approved equal.
    - 3) Area Inlet (Type D&E): D&L I-9163 grate (flat) or D&L 1-3386 grate Type "A" (V-grate), or approved equal.

B. Inlet/Catch Basin Frames and Covers for PVC Units shall be ductile iron manufactured specifically for each basin so as to provide a bottom flange that closely matches the shape and size of the surface drainage inlet.

1. Grates for drain basins shall be capable of supporting various wheel loads as indicated on the construction drawings.
2. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 Grade 70-50-05.
3. Grates and covers shall be provided painted black.

PART 3 - EXECUTION

3.01 INLET/CATCH BASIN INSTALLATION:

- A. Inlets/catch basins shall be constructed to the general dimensions shown in the construction plans. They shall be placed to the proper elevations and grades, and set to match the curb, gutter, and/or valley, both horizontally and vertically.
- B. The connection between the inlet/catch basin and the pipe shall be a smooth, watertight, grouted connection.
  1. This connection shall be grouted from both the inside and outside.

2. Grouting the inside shall result in a smooth transition from the pipe to the inlet/catch basin.
  3. All pipes that connect to the inlet/catch basin shall not extend into the inside wall of the inlet more than 1 inch at any point.
- C. Inlets/catch basins shall be constructed to the general dimensions shown in the construction plans.
1. Inlets/catch basins shall be set on a minimum of 6 inches of 3/4-inch washed gravel that has been firmly placed on undisturbed natural material or natural backfill material that has been compacted to 95% of optimum density as determined by ASTM D698.
- D. The inlet/catch basin frame and cover shall be set on the inlet/catch basin box level and aligned with the concrete curb and gutter.
1. The curb box shall be set to match the height of the existing curb.
  2. New concrete curb and gutter shall be formed and placed to direct flow into the new inlet/catch basin grate.
- E. The PVC basin body will be cut at the time of final grade. No brick, stone, or concrete block will be required to set the grate to the final grade height.
- F. For load rated installations, a concrete slab shall be poured under and around the grate and frame per 033100 - Site Concrete Work and the construction drawings.
- G. After installation, the inlet /catch basin box shall be thoroughly cleaned of debris.

END OF SECTION 334250

## SECTION 340100 - TEMPORARY TRAFFIC CONTROL

### PART 1 - GENERAL

#### 1.01 1.01 WORK INCLUDED:

- A. The work covered consists of furnishing, placing, maintaining and removing the various temporary traffic control setups in accordance with the construction plans and this specification.
- B. The Contractor shall submit a Traffic Control Plan for each street closing to be approved by the Architect/Engineer and City.

#### 1.02 RELATED WORK

- A. City of Gillette Standard Construction Specifications (2025)
- B. Section 312316.13 - Trenching
- C. Section 330500 - Manholes
- D. Section 331100 - Water Main
- E. Section 331110 - Water Valves and Valve Boxes
- F. Section 331150 - Water Service
- G. Section 333100 - Sanitary Sewer Piping
- H. Section 334200 - Storm Sewer Piping
- I. Section 334210 - Culverts
- J. Section 334250 - Storm Sewer Inlets

### PART 2 - PRODUCTS

#### 2.01 MATERIALS:

- A. All barricades, warning signs, lights, temporary signals, and other protective devices shall conform to the provisions for Construction Signing as indicated in the "Manual on Uniform Traffic Control Devices for Streets and Highways" (MUTCD), current edition, published by the Federal Highway Administration. Materials used for the fabrication or erection of such devices shall be approved by the Architect/Engineer before use on the project. Traffic control devices not approved by the Architect/Engineer will not be allowed to be used on the project and their use may justify suspension of Work.

#### 2.02 FLAGGING:

- A. Flagging shall be used to control traffic as required by the Contractor submitted traffic control plans for the Project. Flaggers shall be furnished at each authorized station necessary to safely and efficiently control traffic in and around the work area.
- B. When flagging is required, it shall be performed by trained, competent, properly equipped flaggers supplied by the Contractor.

1. All flaggers shall have completed and passed a Flagger Training Program, such as the flagger training program administered by the Associated General Contractors of Wyoming, prior to performing any flagging on the Project. The approved training and testing may be administered by the Contractor. Compliance with the MUTCD, current edition, standards is required, more specifically Part 6, Chapter 6E.

#### 2.03 TRAFFIC CONTROL MAINTAINER:

- A. The Contractor shall designate an individual(s) who will be responsible at all times to see that all necessary maintenance of traffic control devices is performed. The name of this individual(s) and the telephone number where this person(s) can be contacted at any time will be submitted to the Architect/Engineer before implementing any temporary traffic control on the project.
- B. This individual(s) hereinafter entitled "Traffic Control Maintainer" will be responsible at all times to see that all necessary maintenance of traffic control devices is performed. Maintenance will include, but will not be limited to, the following:
  1. Clean all devices.
  2. Repair, reset or replace any damaged devices.
  3. Reset undamaged devices knocked or blown down.
  4. Replace batteries, light bulbs, control panels, and other components of electrical devices.
  5. Add fuel and motor oil to engines of power generating units for electrical devices and maintain them in good operating condition.
  6. Ensure that all devices remain in their proper locations and are properly positioned in accordance with the Traffic Control Plan in use.
  7. Implement and enforce a system of relief flagging in which every flagger is relieved for at least fifteen (15) minutes every four hours for the duration of their shift.
- C. Failure of Contractor to implement a Traffic Control Maintainer, or failure of Traffic Control Maintainer to comply with the above stipulations will be considered just cause to suspend work.

### PART 3 - EXECUTION

#### 3.01 REQUIREMENTS:

- A. Contractor is responsible for preparing a traffic control plan, which shall be submitted to the Architect/Engineer at least two weeks prior to the beginning of each construction phase.
  1. The Contractor shall coordinate a kick-off meeting with the Architect/Engineer and City to discuss traffic control plans for the project.
  2. The traffic control plans must maintain adequate traffic lanes throughout the area adjacent to construction and be conducive to the safety of motorists and workers.
  3. Construction shall not commence on the portions of the project requiring traffic control until necessary construction warning signs are in place and approved by the Architect/Engineer.
- B. The Contractor shall continuously adjust the temporary traffic control based on changes in work and as requested by the Architect/Engineer and/or City.
- C. The Contractor shall provide signs indicating the businesses affected by the Work. These signs shall be mounted along with detour signs indicating the direction of the detour, also supplied by the Contractor.

- D. No traffic control will be paid for outside of the project limits which results from the haul of the Contractor's secured material sources. Such traffic control shall be approved by the Architect/Engineer and adhere to the provisions for Construction Signing as indicated in the MUTCD, current edition. This additional control will be considered subsidiary to other bid items.
- E. The Contractor shall notify appropriate authorities in advance of any street closure. This includes notifying the City, local media, all emergency services, school districts, Architect/Engineer and all affected residents and businesses at least forty eight (48) hours prior to closing any streets.
  - 1. All notification methods shall be approved by the Architect/Engineer and City prior to notices being completed.
  - 2. WYDOT shall be notified if the project includes or is adjacent to a road under their jurisdiction.
- F. Highways and/or streets closed to traffic shall be protected by barricades and obstructions shall be reflectorized and illuminated during hours of darkness. All flagging stations shall be fully illuminated, if they provide traffic control during hours of darkness.
- G. Reasonable access shall be maintained to each lot. Collector and arterial streets shall provide local access and emergency traffic flow.
- H. Portable signs may be mounted on stands, skids, or on WC-4 Barricades at the option of the Contractor. When not in use, signs and all mounting hardware shall be removed and not cause damage to any property or right of way.

END OF SECTION 340100