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Executive Director

Volume 3 of 3

**Construction Document Submission
For**

**Massillon City Schools District Board
of Education**

New Eastside PK-3 Elementary School

1 Paul E Brown Dr. SE, Massillon, OH 44646

July 12, 2023

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SECTION 210000-Common Work results for Fire Protection

RELATED DOCUMENTS:

All drawings and specifications by Architectural Vision Group. Notice to Bidders, Instructions to Bidders, EEO-Ohio Administrative Code Rules, Agreement Between Owner and Contractor, General Conditions, Special Conditions, and all of the contract requirements.

DESCRIPTION OF WORK:

The work of this Bid Package shall include the following disciplines:

- 1 Common Work Results
- 2 Fire Protection Piping Systems
- 3 Mechanical Identification
- 4 Hangers and Supports

ELABORATION OF WORK:

Provide all labor, materials, equipment, tools, supplies, services and perform all things necessary to complete all work in accordance with the Specifications Sections, Documents and Drawings indicated and requirements as described to complete the intended scope without limitation by the general description. Proposed equals shall be submitted in accordance with the Instruction to Bidders

All products and procedures as described in the following sections.

Section 21 05 30- Through Penetration Fire Stopping

Section 21 10 00- Fire Protection System

Section 22 05 29- Hangers and Supports for Piping and Equipment

Section 22 05 53- Identification for Piping and Equipment

210000 - END OF SECTION

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SECTION 210530 - THROUGH PENETRATION FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Penetrations through fire-resistance-rated vertical assemblies.
 - 2. Penetrations through fire-resistance-rated horizontal assemblies.
 - 3. Penetrations through smoke barriers and smoke partitions.
- B. Related Sections
 - 4. Division 1 – General Requirements.
 - 5. Division 3 – Concrete.
 - 6. Division 4 – Masonry.
 - 7. Division 7 – Thermal and Moisture Protection.
 - 8. Division 9 – Finishes.
 - 9. Division 22 – Plumbing.
 - 10. Division 23 – Heating Ventilating and Air Conditioning.
 - 11. Division 26 – Electrical.
 - 12. Division 27 – Communications.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI/UL 263 - Fire Tests of Building Construction and Materials.
 - 2. ANSI/UL 723 - Surface Burning Characteristics of Building Materials.
 - 3. ANSI/UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Firestops.
 - 4. ASTM E 2174 - Standard Practice for On-Site Inspection of Installed Firestops.
- C. Factory Mutual (FM) - FM4991 - Standard for Approval of Firestop Contractors.
- D. International Code Congress (ICC):
 - 1. International Building Code (IBC).
 - 2. International Residential Code (IRC).
 - 3. International Mechanical Code (IMC).
 - 4. International Fire Code (IFC).
 - 5. International Code Congress Evaluation Service (ICC ES).
- E. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
 - 3. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

4. NFPA 101 - Life Safety Code.
 5. NFPA 5000 – Building Construction and Safety Code.
- F. Underwriters Laboratories (UL) - UL Building Materials Directory:
1. Through-Penetration Firestops Systems (XHEZ).
 2. Firestop Devices (XHJI).
 3. Forming Materials (XHKU),
 4. Wall Opening Protective Materials (CLIV).
 5. Fill, Void or Cavity Materials (XHHW).
- G.; American Society of Sanitary Engineering (ASSE):
1. ASSE Series 9000 – Professional Qualification Standard for Firestop Systems and Device Installers, Inspectors and Surveyors.
- H. International Association of Plumbing and Mechanical Officials (IAPMO):
1. Uniform Plumbing Code (UPC).
 2. Uniform Mechanical Code (UMC).
- I. International Standards Organization (ISO):
1. ISO 6944.
 2. ISO 10295-1: 2007.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide systems that are listed by at least one the following:
1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory".
 2. Intertek Testing Service (Formerly known as Omega Point Laboratories), in "Directory of Listed Products".
 3. Factory Mutual (FM), in FMRC Approval Guide.
 4. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.
- B. Provide firestop products that are flexible enough to allow for pipe vibration in a through penetration application.
- C. Provide products with the appropriate flame spread index and smoke develop index, when tested in accordance with ASTM E 84.
- D. Provide products identical to those tested and listed for classification by UL, Intertek or any other qualified independent testing agency.
- E. Provide products that bear classification marking of qualified independent testing agency.
- F. Where firestop systems not listed by any listing agency are required due to project conditions, submit a substitution proposal with evidence specified.
- G. Use only products specifically listed for use in listed systems.
- H. Provide products that are compatible with each other, with the substrates forming openings, and with the items, if any, penetrating the firestopping, under the conditions represented by this project, based on testing and field performance

demonstrated by manufacturer.

- I. Firestopping materials must meet and be acceptable for use by all applicable codes cited in this section.
- J. Provide products that meet the intent of the state or local and LEED ® guidelines on volatile organic compounds (VOC).
- K. Where applicable provide products that meet the intent of the F rating classification for passage of flame per ASTM E 814 or ANSI/UL 1479 for through penetrations.
- L. Where applicable provide products that meet the intent of the T rating classification for the transfer of temperature per ASTM E 814 or ANSI/UL 1479 for through penetrations.
- M. Where applicable provide systems that meet the intent of the L rating classification for the movement of smoke per ANSI/UL 1479 for through penetrations.
- N. Where applicable provide products that meet the intent of the W rating classification for passage of water per ANSI/UL 1479 for through penetrations.

1.4 SUBMITTALS

- A. Submit under provisions of the Contract and Division 01 – General Requirements.
- B. Shop Drawings: For each firestopping system, provide the following:
 - 1. Listing agency's detailed drawing showing opening, penetrating item(s), and firestopping materials, identified with listing agency's name and number or designation and fire rating achieved.
 - 2. For proposed systems that do not conform strictly to the listing, submit written instructions showing modifications and approved by firestop system manufacturer.
 - 3. Submit under provisions of the International Building Code (IBC) section 703 requiring a submittal package for fire-resistance ratings and fire tests.
- C. Product Certificates: Submit certificates of conformance signed by firestop system manufacturer certifying that materials furnished comply with requirements.
- D. Product Data: Furnish manufacturer's product data sheets on each material to be used in firestop systems. Information on manufacturer's product data sheet should include:
 - 1. Product characteristics including compliance with appropriate ASTM/UL/ANSI test standards.
 - 2. Storage and handling requirements and recommendations.
- E. Installation Instruction: Furnish manufacturer's installation instructions.

1.5 Sustainable or LEED Submittals:

1.6 VOC Content: For sealants and sealant primers, furnish documentation of VOC content.

1.7 QUALITY ASSURANCE

- A. General: All through-penetration firestop systems shall be installed with approved

methods using materials that have been tested and classified to produce an approved assembly.

- B. **Manufacturer Qualifications:** All primary products specified in this section will be supplied by a single manufacturer with a minimum of twenty five (25) years experience in passive fire protection.
 - 1. Products shall be manufactured in a facility that follows ISO 9001 best practices.
 - 2. Products shall have undergone a formal life cycle assessment evaluating environmental impact.
- C. **Installer Qualifications:** Firm must be qualified by having experience, staff, and be properly trained to install the specified products, and meets the following criteria:
 - 1. Contractor is acceptable to manufacturer.
 - 2. Contractor is acceptable to Authority Having Jurisdiction (AHJ).
 - 3. Contractor has completed the manufacturer's certified product installation training.
 - 4. Contractor must provide a list of completed projects as evidence of experience; include project name and address, owner's name and address, and architect's name and phone number.
 - 5. Certificate: Contractor should provide certificate of qualification.
- D. **Codes:** Where manufacturer's application procedures are in conflict with those of the local Authority Having Jurisdiction, the more strict guidelines will prevail.
- E. **Pre-installation Meetings:** Meetings to agree on firestop requirements, conditions, manufacturer's instructions.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products until ready for installation in manufacturer's original unopened packaging, legibly marked with manufacturer's name and product identification, date of manufacture, lot number, listing agency's classification marking, curing/dry time, and mixing instructions (if applicable) and MSDS reference number.
- B. Store and handle in such a manner as to prevent deterioration or damage due to moisture, temperature changes, contaminants, and other causes; follow manufacturer's instructions.
- C. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local Authority Having Jurisdiction (AHJ).

1.9 PROJECT CONDITIONS

- A. Coordinate construction and cutting of openings so that each particular firestop system may be installed in accordance with its listing, including sizing, sleeves, and penetrating items, L rating and manufacturer's published STC rating.
- B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install firestopping under environmental conditions outside manufacturer's absolute limits.

- C. Provide ventilation as required by firestopping manufacturer, including mechanical ventilation if required.

1.10 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: 3M Fire Protection Products
- B. Hilti Firestop Products
- C. STI Firestop

Single Source: To maintain control and integrity of the firestop applications a single manufacturer should be used. Specific UL or approved listing agencies systems applicable to each type of firestop condition should be supplied by one manufacturer.

2.2 SCOPE/APPLICATION

- A. Provide installed firestop products that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations, restoring the integrity of the fire rated construction to its original fire rating.
- B. Provide firestop systems listed for the specific combination of fire-rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:
 - 1. F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
 - 2. T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on exposed side(s) of rated assembly, T-rating must equal its F-rating.
 - 3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures. For those applications that require air leaking protection.
 - 4. W-Rating: meets UL Water Leakage Test, W Rating – Class 1 requirements for systems tested and listed in accordance with ANSI/UL 1479.
 - 5. Wall Penetrations: Through penetration systems must be symmetrical, with the same rating from both sides of the wall. Membrane penetrations may be asymmetrical.
 - 6. Testing: Determine ratings in accordance with ASTM E 814 or UL 1479.

2.3 THROUGH PENETRATION FIRESTOP PRODUCTS

- A. 3M Fire Barrier Cast-in-Place Devices: Firestopping device for use prior to a concrete pour. Adjustable height with pull tabs, straight edge design for close

placement to walls and adjacent devices.

1. Fire Resistance: For use in 1, 2, or 3 hour fire-rated systems.
 2. Locations: Horizontal assemblies only.
- B. 3M Fire Barrier Ultra RC Pack: One piece metal collar assembly encasing intumescent material for firestopping of pipes and cables through rated walls and floors.
1. Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- C. 3M Fire Barrier Ultra Plastic Pipe Device: Intumescent device for firestopping of plastic pipe and cables through rated walls and floors.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Configuration: One-piece metal collar, with locking latch and bendable tabs to secure; equipped also for conventional anchoring.
 3. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- D. 3M Fire Barrier RC-1 Restricting Collar with either FS 195+ Wrap Strip or 3M Interam Ultra GS Wrap Strip. (See product descriptions below): For firestopping of plastic pipes from 4 inches (102 mm) to 10 inches (254mm) in diameter.
1. Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 2. Material: 28 gauge steel.
 3. Size: 25 foot (7.6 m) roll.
 4. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- E. 3M Fire Barrier CP25WB+ Sealant: High-performance, intumescent, water-based sealant. No-sag, fast drying, paintable, red in color. Versatile firestop sealant for pipes (not for use with CPVC), cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- F. 3M Fire Barrier IC 15WB+ Sealant: General-purpose, intumescent, water-based sealant. No-sag, fast drying, paintable, yellow in color. Economical firestop sealant for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- G. 3M Fire Barrier Sealant FD 150+: Single-part, water-based, acrylic latex sealant. No-sag, low-shrinkage, low VOC. Blue, red or limestone color. Used to firestop for pipe penetrations (not for use with CPVC).
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- H. 3M Fire Barrier Water Tight Sealant 3000 WT: Single-part, water-tight, intumescent silicone firestop sealant for filling voids in concrete gypsum, metal, plastic, wood and insulation. Light gray color with black flecks. Meets UL Water Leakage Test, W Rating – Class 1 requirements.

1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 53 when tested in STC 54-rated wall assembly.
- I. 3M Fire Barrier Water Tight 1000 NS Sealant: Single-part, non-slump firestopping silicone sealant for floor and wall openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 56 when tested in STC 56-rated wall assembly.
- J. 3M Fire Barrier Water Tight Sealant 1003 SL: Single-part, self-leveling firestopping silicone sealant for floor openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 2. Locations: For horizontal assemblies only.
 3. STC rating of 56 when tested in STC 56-rated wall assembly.
- K. 3M Fire Barrier Sealant 2000 NS: Single-part, non-slump elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit and electrical wiring.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical and horizontal assemblies.
 3. STC-Rating of 56 when tested in STC 56-rated wall assembly.
- L. 3M Fire Barrier Sealant 2000+: Single-part, elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit and electrical wiring.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical and horizontal assemblies.
 3. STC-Rating of 56 when tested in STC 56-rated wall assembly.
- M. 3M Fire Barrier Moldable Putty+: One-part, 100 percent solids intumescent firestop. Remains pliable, flexible and easily re-enterable. Non-toxic synthetic formula. Versatile putty for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
1. Type: Stick or Pad
 2. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 3. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- N. 3M Fire Barrier 2001 Silicone RTV Foam: Two-part, liquid-silicone elastomer, foams in place when mixed. For use sealing large or complex openings such as cable bundles and cable trays.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- O. 3M Fire Barrier Mortar: For sealing openings in concrete and masonry walls and floors. Self Leveling, non-sag, low VOC.

1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- P. 3M Fire Barrier Self-Locking Pillow: Self-contained, intumescent firestop pillow with interlocking strips. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- Q. 3M Fire Barrier Pillow: Self-contained, intumescent firestop product. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- R. 3M Fire Barrier CS-195+ Composite Sheet: Organic/inorganic intumescent elastomeric sheet, bonded on one side to a layer of 28 gauge galvanized steel. Other side reinforced with steel-wire mesh and covered with aluminum foil. Re-enterable. For use in firestopping larger openings
1. Thickness: Nominal 0.3 inch (7.6 mm).
 2. Thermal Expansion: 8 - 10 times original size.
 3. Tensile Strength (ASTM D412): 93.6 psi (645 kPa)/489 percent.
 4. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems..
 5. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- S. 3M Interam Ultra GS Wrap Strip: Graphite based, flexible, largely inorganic, intumescent mat. For use around non-metallic piping with or with RC-1 collar.
1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems..
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- T. 3M Fire Barrier FS-195+ Wrap/Strip: One-part, organic/inorganic intumescent strip with foil on one side. May be cut to fit irregular shapes. For use around non-metallic piping with or with RC-1 collar.
1. Length: 24 inch (610 mm).
 2. Width: 1 or 2 inches.
 3. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 4. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- U. 3M Fire Barrier Pass-Through Devices: One-Piece device for firestopping of cable penetrations through rated walls and floors.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- V. 3M Fire Barrier Tuck-In: Graphite-based, flexible, intumescent wrap strip for use around non-metallic piping. Adhesive closure tab.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- W. 3M Fire Barrier Putty Sleeve Kit: Device used for firestopping of cable penetrations through fire rated walls and floors.
1. Fire Resistance: For use in 1, 2 3 or 4 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.
- C. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.
- D. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.
- E. Verify that environmental conditions are safe and suitable for installation of firestopping.
- F. If substrate preparation is the responsibility of another installer, notify Architect or Engineer of Record of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Prepare substrates in accordance with manufacturer's instructions and recommendations.
- B. Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.3 INSTALLATION

- A. Install in strict accordance with manufacturer's detailed installation instructions and procedures.
- B. Install so that openings are completely filled and material is securely adhered.
- C. Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.
- D. After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.
- E. Repair or replace defective installations in accordance with manufacturer's recommendations, listed systems details and applicable code requirements.
- F. At each through penetration, attach identification labels on both sides in location where label will be visible to anyone seeking to remove penetrating items or firestopping.
- G. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.

- H. Notify Authority Having Jurisdiction (AHJ) when firestopping installation is ready for inspection; obtain advance approval of anticipated inspection dates and phasing, if any, required to allow subsequent construction to proceed.
- I. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.

3.4 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing agency to inspect installed firestopping and to prepare reports indicating whether the installed work complies with the contract documents.
- B. Notify testing agency at least 7 days prior to date when firestopping installation will be ready for inspection; obtain advance approval of general schedule and phasing, if any, required to allow subsequent construction to proceed.

3.5 CLEANING AND PROTECTION

- A. Remove left over material and debris from Work area. Use necessary means to protect fire protection product(s) before, during, and after installation.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
- C. Install identification Labels for Through Penetration: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:
 - 1. The words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage."
 - 2. Listing agency's system number or designation.
 - 3. System manufacturer's name, address, and phone number.
 - 4. Installer's name, address, and phone number.
 - 5. General contractor's name, address, and phone number (if applicable).
 - 6. Date of installation.

END OF SECTION 210530

SECTION 211000-FIRE PROTECTION SYSTEMS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Piping systems
- B. Sprinkler equipment

1.2 REFERENCES

- A. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.
- F. ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.
- G. ASME B16.25 - Buttwelding Ends.
- H. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated (Galvanized) Welded and Seamless, for Ordinary Uses.
- I. NFPA 13 - Installation of Sprinkler Systems.

1.3 SUBMITTALS

- A. Submit under provisions of Applicable Division I Specifications.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals.
- C. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.
- D. Manufacturer's Field Report: Submit under provisions of Applicable Division I Specifications.
- E. Manufacturer's Field Report: Indicate time of start-up of treatment systems and include analysis of system water after cleaning and treatment.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Applicable Division I Specifications.

- B. Maintenance Instructions: Include installation instructions, spare parts lists, procedures, and treatment programs.

1.5 QUALITY ASSURANCE

- A. Sprinkler Systems: Perform work to NFPA 13.
- B. Welding Materials and Procedures: Perform to ASME Code.
- C. Valves: Bare UL label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- D. Maintain one copy of each document on site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Applicable Division I Specifications.
- B. Deliver and store valves in shipping containers, with labeling in place.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.7 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 SPRINKLER PIPING, BURIED

- A. Steel Pipe: ASTM A153; Schedule 40 black; with ANSI/ASME C105 polyethylene jacket, or double layer, half-lapped 10 mil polyethylene tape.
 - 1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ASTM A234, wrought carbon steel and alloy steel; ASME B16.5, steel flanges and fittings
 - 2. Cast Iron Fittings: ASME B16.1, flanges and fittings.
 - 3. Joints: ANSI/AWS D1.1, welded.
 - 4. Casing: Polyurethane insulation with high-density polyethylene jacket and heat shrink sleeves.

2.2 SPRINKLER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A120; Schedule 40 black or as accepted by NFPA 13.
 - 1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ANSI/ASME B16.25, steel flanges and fittings; ASME B16.11, forged steel socket welded and threaded.

2. Cast Iron Fittings: ASME B16.1, flanges and fittings; ANSI/ASME B16.4, screwed fittings.
3. Malleable Iron Fittings: ASME B16.3, screwed type.
4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.3 SPRINKLER EQUIPMENT

- A. The types of heads shall be used in the following locations;
 1. Unfinished exposed spaces and mechanical space – brass heads, upright.
 2. Finished spaces with ceiling – concealed head assemblies, color to match ceiling color.
 3. Finished spaces in storage room and janitors closets – white pendant heads.
 4. Corridors, locker/shower rooms, restroom – concealed head assemblies, color to match ceiling color.
 5. Heads in the gym shall have wire guards.
- B. Provide vane type water flow indicator with tamper switch and electronic retard.
- C. Provide valve position supervisory switch for monitoring all valves.
- D. Provide test station with valve and drain assembly for testing sprinkler system.
- E. Install water motor gong on building and alarm bell on inside of building at riser area.
- F. Fire Department Connection
 1. Type: Wall mounted with rough chrome plated finish (See Fire Protection plan for approximate location).
 2. Outlets: 4" Siamese storz outlet (verify with Fire Department)
 3. Labeled: Automatic Sprinkler - Fire Department Connection.
- G. Provide wall indicator valve for sprinkler system shut-off. Valve shall be supervised with a tamper switch, not to alarm. Provide flashing strobe light, connected to flow switch, on exterior wall above Fire Department Connection

2.4 GATE VALVES

- A. Manufacturers:
 1. Grinnell.
 2. Viking.
 3. Nibco.
- B. Up to and including 2 Inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, single wedge or disc, threaded ends.
- C. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged or grooved ends.

2.5 GLOBE OR ANGLE VALVES

- A. Manufacturers:
 - 1. Grinnell.
 - 2. Viking.
 - 3. Nibco.
- B. Up to 2 Inches: Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable composition disc, solder or screwed ends, with backseating capacity repackable under pressure.
- C. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.6 BALL VALVES

- A. Manufacturers:
 - 1. Grinnell.
 - 2. Viking.
 - 3. Nibco.
- B. Up to and including 2 Inches: Bronze one piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle and balancing stops, solder or threaded ends with union.
- C. Over 2 Inches: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 10 inches and over, flanged.

2.7 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Grinnell.
 - 2. Viking.
 - 3. Nibco.
- B. Bronze body, stainless steel disc, resilient replaceable seat, threaded ends, extended neck, handwheel and gear drive and integral indicating device and built-in tamper proof switch rated 10 amp at 115 volt AC.
- C. Cast or ductile iron body, chrome plated ductile iron disc, resilient replaceable EPDM seat, wafer or lug ends, extended neck, handwheel and gear drive and integral indicating device and built-in tamper proof switch rated 10 amp at 115 volt AC.

PART 3-EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends to full inside diameter. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.2 INSTALLATION

- A. Install piping in accordance with NFPA 13 for sprinkler systems.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, and not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- G. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- H. Do not penetrate building structural members unless indicated.
- I. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- J. Die cut screw joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- K. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- L. Provide butterfly valves for shut-off or isolating service.
- M. Provide drain valves at main shut-off valves, low points of piping, and apparatus.
- N. Flush entire piping system of foreign matter.
- O. Hydrostatically test entire system.
- P. Require test be witnessed by Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect.
- Q. All underground pipe joints to be exposed until tested and inspected by the Fire Department.

3.3 TRAINING

- A. Fire protection system training to be provided by a trained service technician for a total of

four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year.

- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 211000

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SECTION 220000- COMMON WORK RESULTS FOR PLUMBING

PART 1-GENERAL

1.1 RELATED DOCUMENTS:

All drawings and specifications by Architectural Vision Group. Notice to Bidders, Instructions to Bidders, EEO-Ohio Administrative Code Rules, Agreement Between Owner and Contractor, General Conditions, Special Conditions, and all of the contract requirements.

1.2 DESCRIPTION OF WORK:

The work of this Bid Package shall include the following disciplines:

- 1 Common Work Results
- 2 Hangers and Supports
- 3 Protection of work and property
- 4 Mechanical Identification
- 5 Cutting and Patching
- 6 Plumbing Piping
- 7 Plumbing Specialties
- 8 Plumbing Fixtures and Equipment

1.3 ELABORATION OF WORK:

Provide all labor, materials, equipment, tools, supplies, services and perform all things necessary to complete all work in accordance with the Specifications Sections, Documents and Drawings indicated and requirements as described to complete the intended scope without limitation by the general description. Proposed equals shall be submitted in accordance with the Instruction to Bidders. All components of the plumbing system shall comply with the national safe drinking water act and particularly the reduction in lead in drinking water act. General training to be provided by a trained service technician for a total of four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

All products and procedures as described in the following sections.

Section 22 05 00- Plumbing Piping
Section 22 05 19- Meters and Gages
Section 22 05 23- General Duty Valves for Plumbing
Section 22 05 29- Hangers and Supports for Piping and Equipment
Section 22 05 53- Identification for Piping and Equipment
Section 22 07 00- Plumbing Piping Insulation
Section 22 08 00- Commissioning for Plumbing Systems
Section 22 13 19- Plumbing Specialties
Section 22 13 20- Backflow Prevention Devices
Section 22 13 23- Interceptors
Section 22 14 29- Sump pumps and lift stations
Section 22 34 00- Water Heaters

Section 22 40 00- Plumbing Fixtures
Section 22 62 13 Natural Gas Piping

PART 2-PRODUCTS (NOT USED)

PART 3-EXECUTION (NOT USED)

END OF SECTION 220000

220500-PLUMBING PIPING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Plumbing piping (other than natural gas).

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting materials, sizes, installation requirements, and dimensions.

1.3 QUALITY ASSURANCE

- A. Follow manufacturers requirements for installation.
- B. Soldering procedures per ANSI B16.18.
- C. Comply with ANSI B31 pressure code for pressure piping.

PART 2-PRODUCTS

2.1 PLUMBING PIPING

- A. Domestic water piping above grade shall be Type L hard drawn copper conforming to ASTM B88. Fittings shall be wrought copper conforming to ASTM B16.18. Joints shall be lead-free solder, ASTM B32. Acceptable manufacturers are Mueller and Cerro. (Copper press type of fittings are acceptable)
- B. Sanitary, sanitary vent, and storm piping below slab
 - 1. Schedule 40 PVC with solvent joints per ASTM D2665.
 - 2. Cast iron hub and spigot per ASTM A74.
 - 3. Acceptable manufacturers are Charlotte, Tyler, AB&I, Spears, and Cresline.
- C. Sanitary, sanitary vent, and storm piping above finish floor.
 - 1. Schedule 40 PVC with solvent joints per ASTM D2665 (not in plenums).
 - 2. Cast iron no hub and fittings per ASTM A74.
 - 3. Acceptable manufacturers are Charlotte, Tyler, AB&I, Spears, and Cresline.
- D. Domestic water piping below slab shall be type 'K' soft copper with no joints. Acceptable manufacturers are Mueller and Cerro.
- E. Sump Pump Discharge Piping
 - 1. ASTM D2665 Schedule 40 PVC with solvent joints. Do not run in air plenums.
- F. Sanitary, Sanitary Vent, Storm and Sump Pump Discharge Piping Above Ceilings in Plenum Spaces
 - 1. Cast iron no hub and fittings per ASTM A74.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Terminate vent piping through roof, a minimum of 12 inches above the roof.
- B. Location of vents on the roof shall be a minimum of 20 feet from any wall louver, outside air intake, or rooftop HVAC equipment outside air intake.
- C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- E. Provide pipe hangers and supports as required.
- F. Use ball or butterfly valves with memory stop for shut off and to isolate equipment, part of systems, or vertical risers.
- G. Use ball or butterfly valves with memory stop for throttling, bypass, or manual flow control services.
- H. Use 3/4 inch ball valves with hose end and cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- I. Install in accordance with manufacturer's instructions.
- J. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- K. Route piping in orderly manner and maintain gradient.
- L. Install piping to conserve building space and not interfere with use of space and other work.
- M. Group piping whenever practical at common elevations.
- N. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- O. Provide clearance for installation of insulation and access to valves and fittings.
- P. Provide 24" x 24" access doors where valves are not exposed and are installed where hardboard ceiling occurs.
- Q. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

- R. Insulation of all cold water, hot water, hot water return and storm piping by Plumbing Contractor.
- S. Install bell and spigot pipe with bell end upstream.
- T. Install valves with stems upright or horizontal, not inverted.
- U. Do not attach pipe supports to underside of roof deck.
- V. Metallic pipe or tubing exposed to corrosive action, such as soil conditions or moisture, shall be protected in an approved manner.
- W. Install self-adhesive identification labels on all lines, see Section 22 05 53.
- X. All pipe sizes indicated on plans and/or specifications are inside diameter.
- Y. All drainage and vent piping thru return air plenum to be cast iron except for specialized plenum rated acid waste and vent products specified herein.
- Z. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Disinfect water system per applicable Codes and Regulations and per local jurisdiction requirements.
- C. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651. Report any deficiencies right away.
- D. Disinfection Process: The disinfection is normally carried out by through flushing and then filling the system with chlorinated water at an initial concentration of 50ppm for a contact period of 1 hour. The process has been successful if the free residual chlorine level is not less than 30ppm at the end of this period. The chemicals used to disinfect the system must be approved by the Drinking Water inspectorate for use with the supply of water for drinking, washing, cooking or food production purposes.
- E. Procedure: A small diameter plugged and valved branch needs to be fitted at the upstream end of the supply/service pipe during installation to facilitate disinfection.
 - 1. Thoroughly flush the system to remove any flux residue, swarf or other contaminates, then close all outlets and servicing valve on the supply
 - 2. Using the valved branch, connect a suitable pump, check valve and the storage cistern outlet to the installation
 - 3. Determine the capacity of the system and the quantity of disinfectant to use
 - 4. Add this quantity of water to the cistern and add disinfectant to give the initial strength of 50ppm required, mix then start the pump to inject the disinfectant solution into the system
 - 5. Working away from the temporary connection, open each draw-off fitting until

disinfectant solution is detected then close the fitting to progressively draw the solution around the system.

6. As chlorinated water is drawn off, it will be necessary to add further measured amounts of disinfectant to maintain the initial concentration during the filling process

The 1 hour contact time will start when the entire system has been filled with water containing 50ppm chlorine. If the free residual chlorine measures less than 30ppm at the end of the 1 hour contact period, it will be necessary to repeat the process.

It is vital to thoroughly drain and then flush out all the disinfectant once the 1 hour contact period is complete. Flushing should continue until the level of free chlorine is equal to the level present in the drinking water supplied.

1.1 CLEANING

A. Clean and disinfect 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.

END OF SECTION 220500

SECTION 220519 – METERS AND GAUGES FOR PLUMBING PIPING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Thermometers and fittings.
- B. Pressure gauges and fittings.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting materials, sizes, and dimensions.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Trerice
- B. Ashcroft
- C. Weiss

2.2 COMPONENTS

- A. Thermometers: 1-percent accuracy.
 - 1. Non-toxic, organic filled liquid-in-gas, column type thermometer, rated for potable water.
- B. Pressure Gauges: Phosphor-bronze Bourdon-tube gages, 1-percent accuracy.
 - 1. Vacuum Range: 30 inches Hg of vacuum to 15 psig of pressure.
 - 2. Pressure Range: Two-times operating pressure.
 - 3. Liquid filled pressure gauge where appropriate. Liquid shall be non-toxic, organic type.
 - 4. Rated for portable water/gas as being applied.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Provide thermometers at the following locations:
 - 1. Outlet hot water connections of domestic water heaters.
 - 2. At all domestic thermostatic mixing valve piping connections.
- B. Provide pressure gauges at the following locations:
 - 1. One pressure gauge with 2 independent needle valves piped to the incoming water service.
 - 2. Outlet piping of each water heater with 200 MBH input or greater.

3. Domestic cold water fill connection to the HVAC hydronic loop downstream of the pressure reducing valve.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

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. Bronze ball valves.
 - 2. Iron, single-flange butterfly valves.
 - 3. Bronze butterfly valves
 - 4. Bronze swing check valves.
 - 5. Iron swing check valves.
 - 6. Iron swing check valves with closure control.
 - 7. Bronze gate valves.
 - 8. Iron gate valves.
 - 9. Bronze globe valves.
 - 10. Iron globe valves.
 - 11. Chainwheels.
- 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.
 - 3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 SUBMITTALS

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

1.4 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. To assure uniformity and compatibility, all grooved end valves and adjoining couplings shall be supplied by the same manufacturer.

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. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. 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.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Solder Joint: With sockets according to ASME B16.18.
 - 3. Threaded: With threads according to ASME B1.20.1.
 - 4. Grooved: With grooves according to ANSI/AWWA C606.

2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.

- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Center Line.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. DeZurik Water Controls.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated ductile iron.

2.4 BRONZE BUTTERFLY VALVE

A. 300 CWP, Bronze Butterfly Valves with Elastomer-Coated Ductile Iron Disc:

1. Manufacturers Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Victaulic Series 608
 - b. Anvil - Gruvlok
 - c. Tyco - Shurjoint
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Copper-tube dimensions; suitable for bubble-tight shutoff, bi-directional dead-end service at full rated pressure without use of downstream flange.

- d. Body Material: Bronze CDA-836.
- e. Seat: Double seal EPDM disc coating
- f. Stem: Integrally cast steel.
- g. Disc: EPDM-coated ductile iron

2.5 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. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
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.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. Powell Valves.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.
- h. Closure Control: Factory-installed, exterior lever and spring.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

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

- a. Crane Co.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. Powell Valves.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

2.9 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:

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

- a. Crane Co.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. Powell Valves.

2. Description:

- a. Standard: MSS SP-70, Type I.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Disc: Solid wedge.
- g. Packing and Gasket: Asbestos free.

2.10 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. Powell Valves.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.

2.11 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. Powell Valves.
2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

2.12 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
 - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 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 chainwheels on operators for gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.
- G. Install grooved end valves in accordance with the manufacturer's guidelines and recommendations. A representative shall provide on-site training for contractor's field personnel in the installation of grooved end valves. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.2 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.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate valves.
 - 2. Throttling Service: Globe, ball, or butterfly valves.
 - 3. Pump-Discharge Check Valves:

- a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- 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, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 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. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Bronze Angle Valves: Class 125, bronze disc.
 3. Ball Valves: Two piece, full port, bronze with bronze trim.
 4. Bronze Swing Check Valves: Class 125, bronze disc.
 5. Bronze Gate Valves: Class 125, NRS.
 6. Bronze Globe Valves: Class 125, bronze disc.
- B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, ductile-iron disc.
 3. Iron Swing Check Valves: Class 125, metal seats.
 4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
 5. Iron Gate Valves: Class 125, OS&Y.
 6. Iron Globe Valves: Class 125.
 7. Bronze, Grooved-End Butterfly Valves: 300 CWP, EPDM coated-ductile iron double seal disc.

END OF SECTION 220523

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SECTION 220529- HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Pipe and equipment hangers, supports and associated anchors.
- B. Equipment bases and supports.
- C. Sleeves and seals.
- D. Flashing and sealing equipment and pipe stacks.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings are required and shall include product data noting materials, sizes, and types.

1.3 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. PHD
- B. Michigan
- C. Grinnell

2.2 PIPE HANGERS AND SUPPORTS

- A. Hangers, supports, and components shall be factory fabricated according to MSS SP-58, the latest edition.
- B. Hangers for piping shall be of a compatible material or coating.
- C. Continuous threaded rod shall be used wherever possible. Chain, wire, or perforated straps shall not be permitted.
- D. Concrete inserts into poured concrete floor systems are not permitted.
- E. Supports from roof decking systems are not permitted.
- F. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
- G. Hangers for Pipe Sizes 2 to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Carbon

steel, adjustable, clevis.

- H. Multiple of Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- I. Wall Support for Pipe Sizes 3 Inches: Carbon steel.
- J. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- K. Vertical Support: Steel riser clamp.
- L. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- M. Copper Pipe Support: Carbon steel ring, adjustable, copper plated or plastic coated.
- N. Piping Across Roof: Install on Pate (or equal) equipment support rails with roller supports, all suitable for outdoor installation.

2.3 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.4 INSERTS

- A. Inserts: Malleable iron, case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-Fire Rated Floors: Form with 18 gage galvanized steel.
- B. Sleeves for Pipes Through Non-Fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Form with steel pipe or 16 gage galvanized steel.
- C. Sleeves For Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Stuffing or Fire Stopping Insulation: Glass fiber type, non-combustible.

2.6 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported piping.

2.7 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl

spaces, pipe shafts, and suspended ceiling spaces are not considered exposed. Apply two coats of primer and two coats of epoxy to hangers and supports outdoors.

2.8 SPRING HANGERS

- A. All equipment, water piping, coils, and condensate drains running thru or above sound critical rooms is to be supported with spring isolators as a part of the hangers.

PART 3-EXECUTION

3.1 PIPE HANGERS & SUPPORTS

- A. All hangers and supports shall be attached to the building structural steel system.
- B. Support from steel joist panel point is required.
- C. Support horizontal piping as follows:

	Spacing	Rod Size
1/2 to 1-1/4 inch	6'-6"	3/8"
1-1/2 to 2 inch	10'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
4 to 6 inch	10'-0"	5/8"
PVC - 3/4 to 1 inch	4'-0"	3/8"
PVC - 1-1/4 to 1-1/2 inch	4'-0"	3/8"
PVC - 2 to 2-1/2 inch	4'-0"	3/8"
PVC - 3 to 4 inch	4'-0"	1/2"

- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Place a hanger within 12 inches of each horizontal elbow.
- F. Use hangers with 1-1/2 inch minimum vertical adjustment.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping. Support vertical pipe per code.

3.2 EQUIPMENT BASES AND SUPPORTS

- A. Construct equipment supports of steel angles. Brace and fasten with flanges bolted to structure.

3.3 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

- B. Extend sleeves through floors one inch above finished floor level. Caulk sleeves full depth and provide floor plate.
- C. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing or fire stopping insulation and seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- D. Install chrome plated steel escutcheons at finished surfaces.

END OF SECTION 220529

SECTION 22 05 30 - THROUGH PENETRATION FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Penetrations through fire-resistance-rated vertical assemblies.
 - 2. Penetrations through fire-resistance-rated horizontal assemblies.
 - 3. Penetrations through smoke barriers and smoke partitions.
- B. Related Sections
 - 4. Division 1 – General Requirements.
 - 5. Division 3 – Concrete.
 - 6. Division 4 – Masonry.
 - 7. Division 7 – Thermal and Moisture Protection.
 - 8. Division 9 – Finishes.
 - 9. Division 22 – Plumbing.
 - 10. Division 23 – Heating Ventilating and Air Conditioning.
 - 11. Division 26 – Electrical.
 - 12. Division 27 – Communications.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI/UL 263 - Fire Tests of Building Construction and Materials.
 - 2. ANSI/UL 723 - Surface Burning Characteristics of Building Materials.
 - 3. ANSI/UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Firestops.
 - 4. ASTM E 2174 - Standard Practice for On-Site Inspection of Installed Firestops.
- C. Factory Mutual (FM) - FM4991 - Standard for Approval of Firestop Contractors.
- D. International Code Congress (ICC):
 - 1. International Building Code (IBC).
 - 2. International Residential Code (IRC).
 - 3. International Mechanical Code (IMC).
 - 4. International Fire Code (IFC).
 - 5. International Code Congress Evaluation Service (ICC ES).
- E. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
 - 3. NFPA 96 – Standard for Ventilation Control and Fire Protection of

- Commercial Cooking Operations.
- 4. NFPA 101 - Life Safety Code.
- 5. NFPA 5000 – Building Construction and Safety Code.
- F. Underwriters Laboratories (UL) - UL Building Materials Directory:
 - 1. Through-Penetration Firestops Systems (XHEZ).
 - 2. Firestop Devices (XHJI).
 - 3. Forming Materials (XHKU),
 - 4. Wall Opening Protective Materials (CLIV).
 - 5. Fill, Void or Cavity Materials (XHHW).
- G.; American Society of Sanitary Engineering (ASSE):
 - 1. ASSE Series 9000 – Professional Qualification Standard for Firestop Systems and Device Installers, Inspectors and Surveyors.
- H. International Association of Plumbing and Mechanical Officials (IAPMO):
 - 1. Uniform Plumbing Code (UPC).
 - 2. Uniform Mechanical Code (UMC).
- I. International Standards Organization (ISO):
 - 1. ISO 6944.
 - 2. ISO 10295-1: 2007.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide systems that are listed by at least one the following:
 - 1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory".
 - 2. Intertek Testing Service (Formerly known as Omega Point Laboratories), in "Directory of Listed Products".
 - 3. Factory Mutual (FM), in FMRC Approval Guide.
 - 4. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.
- B. Provide firestop products that are flexible enough to allow for pipe vibration in a through penetration application.
- C. Provide products with the appropriate flame spread index and smoke develop index, when tested in accordance with ASTM E 84.
- D. Provide products identical to those tested and listed for classification by UL, Intertek or any other qualified independent testing agency.
- E. Provide products that bear classification marking of qualified independent testing agency.
- F. Where firestop systems not listed by any listing agency are required due to project conditions, submit a substitution proposal with evidence specified.
- G. Use only products specifically listed for use in listed systems.
- H. Provide products that are compatible with each other, with the substrates forming openings, and with the items, if any, penetrating the firestopping, under the

conditions represented by this project, based on testing and field performance demonstrated by manufacturer.

- I. Firestopping materials must meet and be acceptable for use by all applicable codes cited in this section.
- J. Provide products that meet the intent of the state or local and LEED ® guidelines on volatile organic compounds (VOC).
- K. Where applicable provide products that meet the intent of the F rating classification for passage of flame per ASTM E 814 or ANSI/UL 1479 for through penetrations.
- L. Where applicable provide products that meet the intent of the T rating classification for the transfer of temperature per ASTM E 814 or ANSI/UL 1479 for through penetrations.
- M. Where applicable provide systems that meet the intent of the L rating classification for the movement of smoke per ANSI/UL 1479 for through penetrations.
- N. Where applicable provide products that meet the intent of the W rating classification for passage of water per ANSI/UL 1479 for through penetrations.

1.4 SUBMITTALS

- A. Submit under provisions of the Contract and Division 01 – General Requirements.
- B. Shop Drawings: For each firestopping system, provide the following:
 - 1. Listing agency's detailed drawing showing opening, penetrating item(s), and firestopping materials, identified with listing agency's name and number or designation and fire rating achieved.
 - 2. For proposed systems that do not conform strictly to the listing, submit written instructions showing modifications and approved by firestop system manufacturer.
 - 3. Submit under provisions of the International Building Code (IBC) section 703 requiring a submittal package for fire-resistance ratings and fire tests.
- C. Product Certificates: Submit certificates of conformance signed by firestop system manufacturer certifying that materials furnished comply with requirements.
- D. Product Data: Furnish manufacturer's product data sheets on each material to be used in firestop systems. Information on manufacturer's product data sheet should include:
 - 1. Product characteristics including compliance with appropriate ASTM/UL/ANSI test standards.
 - 2. Storage and handling requirements and recommendations.
- E. Installation Instruction: Furnish manufacturer's installation instructions.
- F. Sustainable or LEED Submittals:
- G. VOC Content: For sealants and sealant primers, furnish documentation of VOC content.

1.5 QUALITY ASSURANCE

- A. General: All through-penetration firestop systems shall be installed with approved methods using materials that have been tested and classified to produce an approved assembly.
- B. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of twenty five (25) years experience in passive fire protection.
 - 1. Products shall be manufactured in a facility that follows ISO 9001 best practices.
 - 2. Products shall have undergone a formal life cycle assessment evaluating environmental impact.
- C. Installer Qualifications: Firm must be qualified by having experience, staff, and be properly trained to install the specified products, and meets the following criteria:
 - 1. Contractor is acceptable to manufacturer.
 - 2. Contractor is acceptable to Authority Having Jurisdiction (AHJ).
 - 3. Contractor has completed the manufacturer's certified product installation training.
 - 4. Contractor must provide a list of completed projects as evidence of experience; include project name and address, owner's name and address, and architect's name and phone number.
 - 5. Certificate: Contractor should provide certificate of qualification.
- D. Codes: Where manufacturer's application procedures are in conflict with those of the local Authority Having Jurisdiction, the more strict guidelines will prevail.
- E. Pre-installation Meetings: Meetings to agree on firestop requirements, conditions, manufacturer's instructions.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products until ready for installation in manufacturer's original unopened packaging, legibly marked with manufacturer's name and product identification, date of manufacture, lot number, listing agency's classification marking, curing/dry time, and mixing instructions (if applicable) and MSDS reference number.
- B. Store and handle in such a manner as to prevent deterioration or damage due to moisture, temperature changes, contaminants, and other causes; follow manufacturer's instructions.
- C. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local Authority Having Jurisdiction (AHJ).

1.7 PROJECT CONDITIONS

- A. Coordinate construction and cutting of openings so that each particular firestop system may be installed in accordance with its listing, including sizing, sleeves, and penetrating items, L rating and manufacturer's published STC rating.
- B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install

firestopping under environmental conditions outside manufacturer's absolute limits.

- C. Provide ventilation as required by firestopping manufacturer, including mechanical ventilation if required.

1.8 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: 3M Fire Protection Products
- B. Hilti Firestop Products
- C. STI Firestop

Single Source: To maintain control and integrity of the firestop applications a single manufacturer should be used. Specific UL or approved listing agencies systems applicable to each type of firestop condition should be supplied by one manufacturer.

2.2 SCOPE/APPLICATION

- A. Provide installed firestop products that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations, restoring the integrity of the fire rated construction to its original fire rating.
- B. Provide firestop systems listed for the specific combination of fire-rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:
 - 1. F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
 - 2. T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on exposed side(s) of rated assembly, T-rating must equal its F-rating.
 - 3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures. For those applications that require air leaking protection.
 - 4. W-Rating: meets UL Water Leakage Test, W Rating – Class 1 requirements for systems tested and listed in accordance with ANSI/UL 1479.
 - 5. Wall Penetrations: Through penetration systems must be symmetrical, with the same rating from both sides of the wall. Membrane penetrations may be asymmetrical.
 - 6. Testing: Determine ratings in accordance with ASTM E 814 or UL 1479.

2.3 THROUGH PENETRATION FIRESTOP PRODUCTS

- A. 3M Fire Barrier Cast-in-Place Devices: Firestopping device for use prior to a concrete pour. Adjustable height with pull tabs, straight edge design for close placement to walls and adjacent devices.
 - 1. Fire Resistance: For use in 1, 2, or 3 hour fire-rated systems.
 - 2. Locations: Horizontal assemblies only.
- B. 3M Fire Barrier Ultra RC Pack: One piece metal collar assembly encasing intumescent material for firestopping of pipes and cables through rated walls and floors.
 - 1. Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- C. 3M Fire Barrier Ultra Plastic Pipe Device: Intumescent device for firestopping of plastic pipe and cables through rated walls and floors.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Configuration: One-piece metal collar, with locking latch and bendable tabs to secure; equipped also for conventional anchoring.
 - 3. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- D. 3M Fire Barrier RC-1 Restricting Collar with either FS 195+ Wrap Strip or 3M Interam Ultra GS Wrap Strip. (See product descriptions below): For firestopping of plastic pipes from 4 inches (102 mm) to 10 inches (254mm) in diameter.
 - 1. Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 - 2. Material: 28 gauge steel.
 - 3. Size: 25 foot (7.6 m) roll.
 - 4. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- E. 3M Fire Barrier CP25WB+ Sealant: High-performance, intumescent, water-based sealant. No-sag, fast drying, paintable, red in color. Versatile firestop sealant for pipes (not for use with CPVC), cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
 - 1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- F. 3M Fire Barrier IC 15WB+ Sealant: General-purpose, intumescent, water-based sealant. No-sag, fast drying, paintable, yellow in color. Economical firestop sealant for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- G. 3M Fire Barrier Sealant FD 150+: Single-part, water-based, acrylic latex sealant. No-sag, low-shrinkage, low VOC. Blue, red or limestone color. Used to firestop for pipe penetrations (not for use with CPVC).
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- H. 3M Fire Barrier Water Tight Sealant 3000 WT: Single-part, water-tight, intumescent silicone firestop sealant for filling voids in concrete gypsum, metal, plastic, wood

and insulation. Light gray color with black flecks. Meets UL Water Leakage Test, W Rating – Class 1 requirements.

1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 53 when tested in STC 54-rated wall assembly.
- I. 3M Fire Barrier Water Tight 1000 NS Sealant: Single-part, non-slump firestopping silicone sealant for floor and wall openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 56 when tested in STC 56-rated wall assembly.
- J. 3M Fire Barrier Water Tight Sealant 1003 SL: Single-part, self-leveling firestopping silicone sealant for floor openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 2. Locations: For horizontal assemblies only.
 3. STC rating of 56 when tested in STC 56-rated wall assembly.
- K. 3M Fire Barrier Sealant 2000 NS: Single-part, non-slump elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit and electrical wiring.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical and horizontal assemblies.
 3. STC-Rating of 56 when tested in STC 56-rated wall assembly.
- L. 3M Fire Barrier Sealant 2000+: Single-part, elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit and electrical wiring.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical and horizontal assemblies.
 3. STC-Rating of 56 when tested in STC 56-rated wall assembly.
- M. 3M Fire Barrier Moldable Putty+: One-part, 100 percent solids intumescent firestop. Remains pliable, flexible and easily re-enterable. Non-toxic synthetic formula. Versatile putty for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
1. Type: Stick or Pad
 2. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 3. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- N. 3M Fire Barrier 2001 Silicone RTV Foam: Two-part, liquid-silicone elastomer, foams in place when mixed. For use sealing large or complex openings such as cable bundles and cable trays.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

- O. 3M Fire Barrier Mortar: For sealing openings in concrete and masonry walls and floors. Self Leveling, non-sag, low VOC.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- P. 3M Fire Barrier Self-Locking Pillow: Self-contained, intumescent firestop pillow with interlocking strips. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- Q. 3M Fire Barrier Pillow: Self-contained, intumescent firestop product. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- R. 3M Fire Barrier CS-195+ Composite Sheet: Organic/inorganic intumescent elastomeric sheet, bonded on one side to a layer of 28 gauge galvanized steel. Other side reinforced with steel-wire mesh and covered with aluminum foil. Re-enterable. For use in firestopping larger openings
 - 1. Thickness: Nominal 0.3 inch (7.6 mm).
 - 2. Thermal Expansion: 8 - 10 times original size.
 - 3. Tensile Strength (ASTM D412): 93.6 psi (645 kPa)/489 percent.
 - 4. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems..
 - 5. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- S. 3M Interam Ultra GS Wrap Strip: Graphite based, flexible, largely inorganic, intumescent mat. For use around non-metallic piping with or with RC-1 collar.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems..
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- T. 3M Fire Barrier FS-195+ Wrap/Strip: One-part, organic/inorganic intumescent strip with foil on one side. May be cut to fit irregular shapes. For use around non-metallic piping with or with RC-1 collar.
 - 1. Length: 24 inch (610 mm).
 - 2. Width: 1 or 2 inches.
 - 3. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - 4. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- U. 3M Fire Barrier Pass-Through Devices: One-Piece device for firestopping of cable penetrations through rated walls and floors.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- V. 3M Fire Barrier Tuck-In: Graphite-based, flexible, intumescent wrap strip for use around non-metallic piping. Adhesive closure tab.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- W. 3M Fire Barrier Putty Sleeve Kit: Device used for firestopping of cable penetrations through fire rated walls and floors.
 - 1. Fire Resistance: For use in 1, 2 3 or 4 hour fire-rated systems.

2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.
- C. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.
- D. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.
- E. Verify that environmental conditions are safe and suitable for installation of firestopping.
- F. If substrate preparation is the responsibility of another installer, notify Architect or Engineer of Record of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Prepare substrates in accordance with manufacturer's instructions and recommendations.
- B. Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.3 INSTALLATION

- A. Install in strict accordance with manufacturer's detailed installation instructions and procedures.
- B. Install so that openings are completely filled and material is securely adhered.
- C. Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.
- D. After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.
- E. Repair or replace defective installations in accordance with manufacturer's recommendations, listed systems details and applicable code requirements.
- F. At each through penetration, attach identification labels on both sides in location where label will be visible to anyone seeking to remove penetrating items or firestopping.

- G. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.
- H. Notify Authority Having Jurisdiction (AHJ) when firestopping installation is ready for inspection; obtain advance approval of anticipated inspection dates and phasing, if any, required to allow subsequent construction to proceed.
- I. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.

3.4 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing agency to inspect installed firestopping and to prepare reports indicating whether the installed work complies with the contract documents.
- B. Notify testing agency at least 7 days prior to date when firestopping installation will be ready for inspection; obtain advance approval of general schedule and phasing, if any, required to allow subsequent construction to proceed.

3.5 CLEANING AND PROTECTION

- A. Remove left over material and debris from Work area. Use necessary means to protect fire protection product(s) before, during, and after installation.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
- C. Install identification Labels for Through Penetration: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:
 - 1. The words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage."
 - 2. Listing agency's system number or designation.
 - 3. System manufacturer's name, address, and phone number.
 - 4. Installer's name, address, and phone number.
 - 5. General contractor's name, address, and phone number (if applicable).
 - 6. Date of installation.

END OF SECTION 220530

SECTION 220553- IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Mechanical identification methods, materials and devices.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting materials, sizes, and dimensions for identification systems.
- C. Submittals are required of valve schedules.

1.3 QUALITY ASSURANCE

- A. Identification requirements shall meet ASME A13.1.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 COMPONENTS

- A. Equipment Nameplates: Aluminum, permanently fastened to equipment, engraved or stamped.
- B. Stencils: Standard stencils shall be black enamel on a white background or white enamel on a dark background.
- C. Snap-on Plastic Pipe Markers: Preprinted, semi-rigid type, color-coded.
- D. Pressure-Sensitive Pipe Markers: Preprinted, color-coded, vinyl type with permanent adhesive.

PIPE	CODE	COLOR
Gas	G	YELLOW/BLACK LETTERS
Domestic Cold Water	DCW	WHITE/GREEN LETTERS
Domestic Hot Water	DHW	WHITE/GREEN LETTERS
Domestic Hot Water Return	DHWR	WHITE/GREEN LETTERS
Plumbing Vent	PV	YELLOW
Sanitary Drain	SAN	BLACK
Storm Drain	ST	BLACK
Make Up Water	MUW	YELLOW
Compressed Air	AIR	BLUE WHITE LETTERS
Fire Protection	F	WHITE/RED LETTERS

- E. Pipe Markers: Full band type.
- F. Plastic Duct Markers: Laminated plastic, color coded, and engraved with the service.
- G. Plastic Tape: Color-coded, pressure-sensitive, self-adhesive vinyl.
- H. Valve Tags: Polished tags with numbers and letters.
 - 1. Plumbing Systems:
 - a. CW – 01 Potable Cold Water
 - b. HW – 01 Potable Hot Water
 - c. RHW – 01 Recirculated Hot Water
 - d. GAS – 01 Natural Gas
 - 2. Fire Protection System
 - a. Zone – 01 Fire Suppression Valve
- I. Access Panel Markers: Engraved plastic laminate.
- J. Engraved Plastic-Laminate Signs: Sizes required to contain message.
- K. Plastic Equipment Markers: Standard color-coded, laminated plastic.
- L. Plasticize Tags: Preprinted, accident prevention.
- M. Valve Location Tags: All labels to be ½"x 3" or larger plastic laminate with engraved letters 3/16" high attached to the ceiling grid. The labels should have the mark number or valve tag number. The CMSD standard colors are as follows:

1. Domestic Cold Water Valves	White/Green letters	(CW-01)
2. Domestic Hot Water Valves	White/Green letters	(HW-01)
3. Gas Valves	Yellow/Black letters	(Gas-01)
4. Compressed Air	Blue/White letters	(Air-01)
5. Fire Suppression Valves	White/ Red letters	(Zone-A)

2.2 VALVE CHARTS

- A. Valve charts shall be furnished by each respective Contractor and shall include the following items:
 - 1. Valve identification
 - 2. Location
 - 3. Purpose
- B. Valve charts shall be included in the Maintenance and Operating Manuals.

PART 3-EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Piping, equipment and valve identification shall be completed prior to issuance of substantial completion.
- B. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.
- C. Equipment: Identify water heaters with plastic nameplates. Pumps must be identified with metal tags.
- D. Controls: Identify control panels and major control components outside panels with plastic nameplates.
- E. Install plastic pipe markers in accordance with manufacturer's instructions.
- F. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- H. Identify all disconnects and starters related to Plumbing and Fire Protection equipment.
- I. Identify piping, concealed or exposed with plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Identify pressure of high temperature hot water in addition to service, flow direction and temperature.
- J. Provide ceiling labels to locate items specified above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 220553

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SECTION- 220700 - PLUMBING PIPING INSULATION

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Interior pipe insulation, jackets, and accessories.
- B. Field-applied insulation on hot and cold equipment surfaces.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Submittals are required and shall include product data noting materials, thickness for each service or piece of equipment, aged thermal qualities, and accessories.

1.3 QUALITY ASSURANCE

- A. Fire performance characteristics in accordance with ASTM E 84 for flame spread of 25 and smoke developed of 50.
- B. Materials and installation in accordance with NFPA 255 and UL 723.

PART 2-PRODUCTS

2.1 MATERIALS

- A. Glass Fiber: With ASJ jacket (unless noted otherwise) and with vapor-barrier.
 - 1. Preformed Pipe Insulation: ASTM C 547, Class I, rigid, minimum density to be 3.5 pcf, Owens Corning SSL II with ASJ Max jacket (or equal).
 - 2. Board Insulation: ASTM C 612, Type 2, rigid and semi-rigid. Minimum density to be 6 pcf. Owens Corning 705 or equal.
 - 3. Blanket: ASTM C 553, Type II, Class F-1, with FSK vapor barrier jacket, minimum density to be 1 pcf, Owens Corning Type 100 SOFTR Duct Wrap FRK or equal.
 - 4. Adhesive: UL Classification; Nonflammable, and as recommended by insulation manufacturers.
 - 5. Pre-formed Pipe and Tank Insulation: ASTM C1393, Owens Corning Fiberglas Pipe and Tank with ASJ Max jacket
 - 6. Maximum "K" Value: 0.27 at 75 degrees F.
- B. Flexible Elastomeric Cellular: Flexible cellular elastomeric material, molded or sheet.
 - 1. Preformed: ASTM C534, Type II.
 - 2. Adhesive: Waterproof vapor retarder, as recommended by insulation manufacturer.
 - 3. Maximum "K" Value: 0.245 at 75 degrees F.
- C. Insulating Cements
 - 1. Mineral fiber, hydraulic-setting insulating and finishing cement.
 - 2. Expanded or exfoliated vermiculite.

- D. Adhesives: MIL-A-3316C, Classes 1 and 2, Grade A.
- E. Field Applied Protective Jackets for Mechanical Rooms, Storage Rooms, Boiler Rooms, and Any Other Room or Location Subject To Abuse (All below 8' level): Field applied jackets for protection of plumbing piping and equipment shall be 30 mil, 25/50 rated PVC by Speedline or Proto.

2.2 MANUFACTURER'S

- A. Acceptable manufacturers for glass fiber insulation are Owens-Corning, Manville, Knauf, and Certainteed.
- B. Acceptable manufacturers for flexible elastomeric insulation are Armacell and Rubatex.
- C. Acceptable manufacturers for ADA fixture piping protective wraps/covers are Truebro and Brocar as called out below in PART 3.

PART 3-EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Leak test piping system before installing insulation systems.

3.2 INSTALLATION

- A. Install material in accordance with manufacturer's recommendations and in conformance with building codes and industry standards. Refer to Section 220529 for requirements on inserts and shields.
- B. A continuous vapor barrier is required for all piping and equipment with a fluid temperature or surface below the ambient air temperature.
- C. Provide proper support at piping hanger systems.
- D. Insulate valves and fittings in cold water systems.
- E. Insulated cold pipes and equipment conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory applied.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
 - 3. PVC fitting covers may be used.
 - 4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 - 5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, chilled water pump bodies, and expansion joints.
- F. For insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with vapor barrier factory applied.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
 - 3. PVC fitting covers may be used.
 - 4. For hot piping and equipment conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
 - 5. For hot piping and equipment conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

G. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops at lavatories shall be insulated and finished with Truebro Model No. 102 "Lav-Guard" or Brocar "Trap-Wrap" white insulation kits.

H. Finish insulation at supports, protrusions, and interruptions.

3.3 INSULATION SCHEDULE

	Service	Pipe Size	Insulation
A.	Plumbing hot water, cold water, and hot water recirc piping.	Up thru 1-½" >1 ½"	1" 1.5"
B.	Non-vertical storm water conductors, roof drain bodies, and the first two feet of vertical storm water conductors.	All	1"
C.	Drip pan drain piping. Plumbing drain lines and trap from floor drains in equipment room not located on grade to a point 10'-0" from trap. Electric water cooler waste traps.		Flame retardant flexible elastomeric pipe insulation 1/2" thick. Seal all joints with #520 adhesive. Insulate all valves and fittings to match adjacent piping.
D.	Domestic cold water equipment and tanks	All	1"

END OF SECTION 220700

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SECTION 220800-COMMISSIONING OF PLUMBING SYSTEMS

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 refers contractors to commissioning process requirements for plumbing systems, assemblies, and equipment found in related division 01 sections.
- B. Related Sections:
 - 1. Division 01 Section 019113 "Commissioning Requirements" for definitions, roles and responsibilities, and process requirements for all systems to be commissioned.

1.3 DESCRIPTION

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify and document proper performance of equipment and systems.
 - 3. Verify that the Owner's operating personnel are adequately trained.
- B. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 220800

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SECTION 221319- PLUMBING SPECIALTIES

PART 1-GENERAL

1.1 WORK INCLUDED

- A. Roof drains
- B. Floor drains
- C. Floor Sinks
- D. Cleanouts.
- E. Water hammer arrestors.
- F. Wall Hydrants
- G. Hose Bibb
- H. Water/Gas Energy Monitor Meters

1.2 REFERENCES

- A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
- B. ANSI A112.21.1 - Floor Drains.
- C. ANSI A112.26.1 - Water Hammer Arresters.
- D. ASME A112.36.2 - Cleanouts.
- E. ASSE 1019 – Wall Hydrants

1.3 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.4 SUBMITTALS

- A. Submit shop drawings and product data per Applicable Division I Specifications.
- B. Include component sizes, rough-in requirements, service sizes, and finishes.

1.5 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 ROOF DRAIN (RD)

- A. Acceptable Manufacturers
1. J.R. Smith
 2. Watts
 3. Zurn
- B. Duco cast iron body with adjustable extension sleeve, flashing clamp, gravel stop, dome, and sump receiver; J.R. Smith 1015-Y-C-R (size per plans).

2.2 EMERGENCY ROOF DRAIN (ERD)

- A. Acceptable Manufacturers
1. J.R. Smith
 2. Watts
 3. Zurn
- B. Duco cast iron body with adjustable extension sleeve, flashing clamp, gravel stop, dome water dam, and sump receiver: J.R. Smith No. 1080-Y-C-R (size per plans).

2.3 FLOOR DRAIN-1 (3" FD-1)

- A. Acceptable Manufacturers
1. J.R. Smith
 2. Watts
 3. Zurn
- B. Duco cast iron body and flashing collar with nickel bronze adjustable strainer head; J.R. Smith No. 2005 (size per plans) Provide and install ASSE 1072 trap seal for each floor drain in lieu of trap primers.

2.5 FLOOR SINK (4" FS)

- A. Acceptable Manufacturers
1. J.R. Smith
 2. Watts
 3. Zurn
- B. Duco cast iron body and flashing collar with nickel bronze ½ grate, square top, J.R. Smith No. 3100Y-12 (size per plans).

2.6 CLEANOUTS (CO)

- A. Acceptable Manufacturers
 - 1. J.R. Smith
 - 2. Watts
 - 3. Zurn
- B. Floor Cleanout: Duco cast iron with round adjustable scoriated secured nickel-bronze top; J.R. Smith No. 4020.
- C. Wall Cleanout: Duco cast iron spigot ferrule with cast bronze taper threaded plug with stainless steel round cover; J.R. Smith No. 4402.

2.7 WATER HAMMER ARRESTORS

- A. Acceptable Manufacturers
 - 1. J. R. Smith
 - 2. Watts
 - 3. Zurn
- B. ANSI A112.26.1; sized in accordance with PDI WH-201, precharged suitable for operation in temperature range, 100 to 300 degrees F and maximum 250 psig working pressure; Model #5000 series manufactured by J.R. Smith.

2.8 WALL HYDRANT (WH-A)

- A. Acceptable Manufacturers
 - 1. Zurn
 - 2. J.R. Smith
 - 3. Watts
- B. Bronze body, stainless steel box, bronze parts, hose connection, integral vacuum breaker and operating keylock: Zurn No. Z-1350.

2.9 WALL HYDRANT (WH-B)

- A. Acceptable Manufacturers
 - 1. J.R. Smith
 - 2. Zurn
 - 3. Watts
- B. Bronze hydrant with hose connection, integral vacuum breaker and "T" handle key, non-freeze; J.R. Smith No. 5509QT.

2.10 HOSE BIBB (HB)

- A. Acceptable Manufacturers
 - 1. Chicago Faucet
 - 2. Woodford

3. Acorn

- B. Single water fitting with vacuum breaker, spout, ¾" integrated hose threaded outlet, loose key cap with 293-6 removable tee handle, chrome plated finish; Chicago Faucet No. 952.

2.11 ENERGY MONITORING METERS

A. Water Monitoring Meter

Provide water flowmeter in location shown on drawings. Meters shall be line sized of the compound or magnetic type. Readout shall be in gallons. Provide 4-20MA or 0-10 VDC output to Building Automation System, coordinate with controls contractor. Water meter flow range ½-100 GPM, pressure rating of 30-150 psi, accuracy of 1.5 percent between minimum and maximum flow range. Install usage meters and by-pass with three isolation valves around meters as required. Bypass line and isolation valves to be line size. Wiring by controls contractor.

B. Gas Monitoring Meter

Provide natural gas meter with pulser type index to monitor total building usage. The meter shall be installed downstream of the utility company service meter as shown on drawings. BAS / Direct Digital Control system shall interface with gas meter to monitor gas usage and provide reports. Meter shall be American Metering Company, or equal by Sensus Metering Systems or Schlumberger RMS. Install usage meters and by-pass with three isolation valves around meters as required. Bypass line and isolation valves to be line size. Wiring by controls contractor.

END OF SECTION 221319

SECTION 221320- BACKFLOW PREVENTION DEVICES

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Reduced pressure backflow preventer (Domestic)
- B. Double check detector backflow preventer (Fire)

1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. Provide backflow prevention devices wherever possible sources of undesirable materials are connected to the potable water system.
- B. The backflow prevention devices shall meet the standards set by the American Society of Sanitary Engineers and the latest addition to the Plumbing Code, Chapter 4101:2-69-01 and air gap standards under American National Standards Institute A112.1.2-1942(1979).
- C. The backflow prevention devices shall be approved for use by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.
- D. Dual check valve per ANSI/ASSE 1024, CSA B64.6.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 BACKFLOW PREVENTORS

- A. Acceptable Manufacturers
 - 1. Watts
 - 2. Conbraco
 - 3. Zurn
- B. See model number on plans.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install reduced pressure backflow preventer on domestic water service (see schematic on

plans).

- B. Install double detector check backflow preventer on fire protection water service (see schematic on plans).
- C. Units shall be installed in strict accordance with manufacturer's written instructions.
- D. Test each backflow device and submit test data.

221320 END OF SECTION

SECTION 221323- INTERCEPTORS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Grease interceptor
- B. Oil interceptor

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.

1.3 QUALITY ASSURANCE

- A. Grease interceptors shall meet the latest addition of PDI Seal of Approval and Ohio Plumbing Code.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 GREASE INTERCEPTOR

- A. Acceptable Manufacturers
 - 1. Mack Industries
 - 2. Poland Concrete Products
 - 3. McGill Septic Tank
- B. The interceptor capacity shall be 1,000 gallons, constructed of concrete; Mack Industries Dwg. E-2A
- C. Provide cleanouts at each end of the tank with access up to grade.
- D. Provide access to grade, using a 2'-0" diameter concrete collar with a cast iron frame and lid, 4 inches above finish grade.

2.2 OIL INTERCEPTOR (Below Grade)

- A. Acceptable Manufacturers
 - 1. Watts
 - 2. Zurn
 - 3. J.R. Smith
- B. The interceptor capacity shall be 10 GPM, by Watts model OI-10-B
- C. Provide cleanouts at each end of the tank with access up to grade.

PART 3-EXECUTION

3.1 GREASE INTERCEPTOR

- A. Provide a minimum of 2'-0" cover over the tank.
- B. Set tank on a 6 inch bed of compacted granular material. Backfill around the tank to within 12 inches of grade with compacted granular material.

END OF SECTION 221323

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sump pumps.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 ELEVATOR SUMP PUMP

- A. Submersible, Fixed-Position, Single-Seal Sump Pump:
 - 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. Stancor, Inc.
 - b. Weil Pump Co.
 - c. Zoeller Company.
 - 2. Provide pump and control systems capable of pumping water while containing oil. The system shall function automatically and shall provide for an alarm and separate LED lights in the event of (a) the presence of oil in the sump, (b) high liquid in the sump, or (c) high amps or a locked rotor condition. In addition, LED lights shall be provided for (1) power and (2) pump run function. An alarm that sounds only in the event of a high liquid condition or does not separately identify the above five functions shall not be acceptable.

3. The pump shall be a submersible type and shall be approved to UL 778 standards and shall include thermal and overload protection. The motor housing shall be constructed of #304 stainless steel and mechanical seats shall be housed in a separate oil-filled compartment.
4. The main control shall be approved to UL 508 standards and housed in a gasketed NEMA 4X enclosure with a see-through window for observation of operating functions. The control shall be equipped with an 8-pin twist lock receptacle, dual solid state Oil-Minder relays with variable sensitivity settings, an over current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with alarm silencing switch, dual floats, clearly marked terminal board and remote monitoring contact. A NEMA 4X junction box with 8-pin twist-lock electrical receptacle and 25' (additional lengths if required shall be provided) of mating 8 conductor cable shall be provided. All cables between the pump and junction box shall be 16' long and the cable and plug from the control unit shall be 8' long. The control unit, junction box, pump, floats and sensor shall be factory assembled as a complete, ready-to-use system and shall be tested and approved as a complete system by a nationally recognized testing laboratory such as ENTELA. The system shall allow for the main control to be located outside of the elevator hoistway to be monitored for all functions without having to enter the elevator shaft.

2.2 SUMP PUMP CAPACITIES AND CHARACTERISTICS

- A. For capacities and electrical characteristics see schedule on drawings.
- B. Number of Pumps: See schedule on drawings.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing 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 26 Sections.
- B. Motors for submersible pumps shall be hermetically sealed.

2.4 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: See detail on drawings.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Division 31 Section "Earth Moving."

3.2 INSTALLATION

- A. Pump Installation Standard: Comply with HI 1.4 for installation of sump pumps.

END OF SECTION 221429

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SECTION 223400-WATER HEATERS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Gas Fired Water Heaters

1.2 QUALITY ASSURANCE

- A. Gas units shall meet AGA requirements and CSA international standards.
- B. Units must meet ASHRAE 90.1, ADDM 90 pounds.
- C. The gas heater shall be ASME certified for 160-psi operation.
- D. Heater shall be rated at a minimum of 82 percent efficiency.
- E. Ensure products and installation of specified products are in conformance with recommendations and requirements of the manufacturer.
- F. Sequence of Operation ASHRAE Standard 90.1 requirements.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under Applicable Division I Specification.
- B. Provide Manufacturer's Installation Instructions.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Applicable Division I Specification.
- B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.5 REGULATORY REQUIREMENTS

- A. Conform to NFPA 54, NFPA 70, UL 174, UL 1453 requirements for water heaters.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Applicable Division I Specification.

1.7 WARRANTY

- A. Provide warranty under provisions of Applicable Division I Specification.
- B. Warranty: Include coverage of domestic water heaters. Water heater heat exchanger and storage tank shall have a warranty of five (5) years.

PART 2-PRODUCTS

2.1 HOT WATER HEATERS

- A. Acceptable Manufacturers - HWH
 1. Bradford-White
 2. A.O. Smith
 3. PVI
 4. Lochinvar
- B. Acceptable Manufacturers – Circulating Pumps
 1. Taco
 2. Bell & Gosset
 3. Weinman
- C. Acceptable Manufacturers – Expansion Tanks
 1. Amtrol
 2. Taco
 3. Bell & Gosset
- D. See details on plans.

PART 3-EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Install equipment in accordance with manufacturers' instructions to permit intended performance.
- B. Install equipment and piping in an orderly manner.
- C. Verify part and model numbers with supplier.
- D. Provide all components necessary to make systems operational.
- E. Provide for equal flow thru the heaters.

3.2 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for a total of two (2) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 223400

SECTION 224000- PLUMBING FIXTURES

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Water closets
- B. Urinals
- C. Lavatories
- D. Sinks
- E. Mop basin
- F. Electric water coolers
- G. Shower

1.2 REFERENCES

- A. ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
- C. ASME A112.19.2 - Vitreous China Plumbing Fixtures.
- D. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
- E. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards).
- F. ARI 1010 - Drinking-Fountains and self-contained, Mechanically- Refrigerated Drinking Water Coolers. Provide lead-free per NSF 372.

1.3 QUALITY ASSURANCE

- A. Meet requirements of Ohio Plumbing Code.
- B. Fixtures: By same manufacturer for each product specified throughout.
- C. Trim: By same manufacturer for each product specified throughout.

1.4 SUBMITTALS

- A. Submit product data under provisions of Applicable Division I Specification.
- B. Include fixtures, sizes, utility sizes, trim, and finishes.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Applicable Division I Specification.
- B. Include fixture trim exploded view and replacement parts lists.

1.6 WARRANTY

- A. Warranty: Include coverage of electric water cooler compressor.
- B. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Water Closets
 - 1. Sloan
 - 2. American Standard
 - 3. Zurn
- B. Urinals
 - 1. Sloan
 - 2. American Standard
 - 3. Zurn
- C. Flush Valves
 - 1. Sloan
 - 2. Zurn
 - 3. American Standard
- D. Water Closet Seats
 - 1. Bemis
 - 2. Olsonite
 - 3. Beneke
 - 4. Church
- E. Fixture Carriers
 - 1. J.R. Smith
 - 2. Watts
 - 3. Zurn
- F. Lavatories
 - 1. American Standard
 - 2. Bradley
 - 3. Sloan
 - 4. Zurn

- 5. Kohler
- H. Lavatory Faucets
 - 1. Sloan
 - 2. Zurn
 - 3. Chicago Faucet
 - 4. Kohler
- I. Sinks
 - 1. Just
 - 2. Elkay
 - 3. Dayton
 - 4. Moen
- J. Sink Faucets
 - 1. Chicago Faucet
 - 2. Peerless
 - 3. Kohler
 - 4. Moen
- K. Mop Basin
 - 1. Mustee
 - 2. Fiat
 - 3. Swan
 - 4. Zurn
- L. Electric Water Coolers
 - 1. Oasis
 - 2. Elkay
 - 3. Halsey Taylor
- M. Showers
 - 1. Clarion Bathware
 - 2. Bradley
 - 3. Acorn
 - 4. Zurn
 - 5. Leonard

2.2 WATER CLOSET (WC-A, WC-B)

- A. Bowl: Wall mounted, vitreous china, elongated rim; Sloan Model No. WETS-2450.1010 with manually operated flush valve, Sloan Model No. 111 – 1.28 GPF. Mount WC-B at handicap height. Carrier as required.
- B. Seat: Solid white plastic, open front, stainless steel hinge, without cover; Bemis Model No. 1955CT (White).

2.3 URINAL (UR-A, UR-B)

- A. Urinal: Vitreous china, wall hung wash down, integral trap, 3/4 inch top spud, Sloan Model No. WEUS-1000.1010 with manually operated flush valve, Sloan Model No. 186.0- .125 GPF. Mount Urinal-B at handicap height.

2.4 LAVATORY (LAV-A)

- A. Express two user lavatory system – EXD Series; Bradley No. EXD-2N (Color by Arch.) provide with Aerada 900 series faucet and S45-2678 .35 GPM aerator; soap dispenser 6324-68. Install ASSE 1070 mixing valve.

2.5 LAVATORY (LAV-B)(ADA)

- B. Basin: Vitreous china wall mounted, 21" x 18", 4" faucet centers, Model 0355.012 by American Standard. Floor mounted support in chase areas, wall mounted support in non-chase areas.
- C. Sloan hardwired faucet model no. ETF-80, 0.35 GPM, sensor operated, transformer mounted per manufacturer recommendation. Chrome plated offset wheelchair grid drain, chrome plated 1-1/4 inch 17 gauge brass P-trap and arm with escutcheon; 3/8 inch loose key angle stops with flexible supplies. Install Trap Wrap (or approved equal) to supply and drain lines. Install ASSE 1070 mixing valve.

2.6 SINK-A (ADA)

- A. Bowl: Single compartment, 19" x 20" outside dimensions, 18-gauge type 304 stainless steel, self-rimming with undercoating. Model No. SL-ADA-2019-A-GR by Just (6.5" DP) Center rear drain.
- B. Faucet: Chicago Faucet No. 895-317GN2AE73ABCP chrome plated, 5 1/4" rigid/swing gooseneck spout, 1.0 GPM aerator and wristblade handles.
- C. Bubbler: Chicago Faucet No. 748-244ABCP mounted on right side of sink.
- D. Trim: Stainless steel cup strainer with removable basket and 1 1/2" chrome plated brass tailpiece; Chrome plated 1 1/2" 17-gauge brass P-trap and arm with escutcheon, 3/8 loose key angle stops with flexible supplies. Install ASSE 1070 mixing valve.

2.7 SINK-B (ADA)

- A. Bowl: Single compartment, 19" x 20" outside dimensions, 18-gauge type 304 stainless steel, self-rimming with undercoating. Model No. SL-ADA-2019-A-GR by Just (6.5" DP) Center rear drain.
- B. Faucet: Chicago Faucet No. 895-317GN2AE73ABCP, chrome plated, 5 1/4" rigid/swing gooseneck spout, 1.0 GPM aerator and wristblade handles.
- C. Trim: Stainless steel cup strainer with removable basket and 1 1/2" offset chrome plated brass

tailpiece; Chrome plated 1 ½” 17-gauge brass P-trap and arm with escutcheon, 3/8” loose key angle stops with flexible supplies. Install ASSE 1070 mixing valve.

2.8 SINK-C (ADA)

- A. Bowl: Single compartment, 19” x 20” outside dimensions, 18-gauge type 304 stainless steel, self-rimming with undercoating. Model No. SL-ADA-2019-A-GR by Just (6.5” DP) Center rear drain.
- B. Faucet: Chicago Faucet No. 895-317GN2AE73ABCP, chrome plated, 5 ¼” rigid/swing gooseneck spout, 1.0 GPM aerator and wristblade handles.
- C. Trim: Stainless steel cup strainer with removable basket and 1 ½” chrome plated brass tailpiece; Chrome plated 1 ½” 17-gauge brass P-trap and arm with escutcheon, 3/8” loose key angle stops with flexible supplies. Install ASSE 1070 mixing valve.
- B. Install suspended type solids interceptor, J.R. Smith No. 8730.

2.9 SINK-D (ADA)

- A. Bowl: Single compartment, 19” x 20” outside dimensions, 18-gauge type 304 stainless steel, self-rimming with undercoating. Model No. SL-ADA-2019-A-GR by Just (6.5” DP) Center rear drain.
- B. Faucet: Chicago Faucet No. 895-317GN2AE73ABCP, chrome plated, 5 ¼” rigid/swing gooseneck spout, 1.0 GPM aerator and wristblade handles.
- C. Trim: Stainless steel cup strainer with removable basket and 1 ½” offset chrome plated brass tailpiece; Chrome plated 1 ½” 17-gauge brass P-trap and arm with escutcheon, 3/8” loose key angle stops with flexible supplies. Install ASSE 1070 mixing valve.
- D. Install suspended type solids interceptor, J.R. Smith No. 8730.

2.9 MOP BASIN (MB)

- A. Mustee Model No. 63M, 24”x24”, molded fiberglass, with No. 63.600A service faucet, 65.700 hose and hose bracket, 65.600 mop hanger, 67.2436 wall guards, and 63.401 bumper guard.

2.10 ELECTRIC WATER COOLER (EWC)

- A. Surface mounted, Hi-Lo with bottle filler; with stainless steel top, elevated anti-squirt bubbler with stream guard, automatic stream regulator, mounting bracket, refrigerated high efficiency cooling system; Model No. PG8EBFSL by Oasis.

2.12 SHOWER (SHR-A)(ADA)

- A. 38” x 37” barrier free shower by Clarion Bathware with left hand fixture wall, #503218

grab bar, #5018 grab bar, #400-33.5"-SDL folding seat, #HHS-30CE (1.5 GPM)
handheld shower with stainless steel glide rails, #CH-SSMV pressure balancing anti-
scald mixing valve, #CR 35 1/2" curtain rod, #660 soap dish and 2" brass drain.

PART 3-EXECUTION

3.1 INSPECTION WS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
- B. Verify adjacent construction is ready to receive rough-in work of this Section.

3.2 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with carriers and bolts.
- E. Maintain fixtures to heights above finished floor per architectural plans.
- F. Install all fixtures per manufacturer's specifications.

END OF SECTION 224000

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226313-NATURAL GAS PIPING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Pipes, tubes and fittings
- B. Piping specialties
- C. Piping and tubing joining materials
- D. Valves
- E. Pressure regulators
- F. Mechanical sleeve seals
- G. Grout

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification for each of the following:
 - 1. Piping specialties and valves.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Escutcheons.
- B. Qualification Data: For qualified professional engineer.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For pressure regulators and for valves, to include in emergency, operation, and maintenance manuals.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.
- B. Natural Gas System Pressure within Building: Two pressure ranges. Primary pressure is more

than 0.5 psi but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Construction Manager's and Owner's written permission.

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.
 - 4. Forged-steel flanges and flanged fittings: ASME B16.5 minimum Class 150 including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped face: not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.21, carbon steel aboveground and stainless steel underground.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC1.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation; Parflex Division.
 - c. Titeflex.
 - d. Tru-Flex Metal Hose Corp.
 - 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 Stainless steel.
 - 3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1.) Flame-Spread Index: 25 or less.
 - 2.) Smoke-Developed Index: 50 or less.
 - 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 - 5. Striker Plates: Steel, designed to protect tubing from penetrations.
 - 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded Connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 - 7. Operating-Pressure Rating: 5 psig.
- C. Site underground natural gas piping.
- Polyethylene (PE) Pipe: Yellow-Medium-gas pipe, plastic, PE-2406, ASTM D-1505, ASTM D-2638, ASTM D-2440, ASTM D-2837, ASTM D 2513, SDR 11.

- a. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
- b. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
- c. Anodeless Service-Line Risers: Factory fabricated, and leak tested.
 - 1) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - 2) Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
 - 3) Aboveground Portion: PE transition fitting.
 - 4) Outlet shall be threaded or flanged or suitable for welded connection.
 - 5) Tracer wire connection.
 - 6) Ultraviolet shield.
 - 7) Stake supports with factory finish to match steel pipe casing or carrier pipe.
- d. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - 1) PE body with molded-in, stainless-steel support ring.
 - 2) Buna-nitrile seals.
 - 3) Acetal collets.
- e. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - 1) Fiber-reinforced plastic body.
 - 2) PE body tube.
 - 3) Buna-nitrile seals.
 - 4) Acetal collets.
 - 5) Stainless-steel bolts, nuts, and washers.
- f. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - 1) Stainless-steel flanges and tube with epoxy finish.
 - 2) Buna-nitrile seals.
 - 3) Stainless-steel bolts, washers, and nuts.
 - 4) Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors

- 1. Indoor, Fixed- Appliance Flexible Connectors: Comply with ANSI Z21.24.
- 2. Corrugated stainless-steel tubing with polymer coating.

3. End Fittings: Zinc-coated steel.
4. Threaded Ends: Comply with ASME B1.20.1.
5. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.

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. Common Joining Materials: Refer to Division 22 Section "Common Work Results for Plumbing."

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. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Listing: Listed and Labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brass Craft 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. Bail: Chrome-plated brass.
4. Stern: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stern packing threaded ends.
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.

E. 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. Brass Craft 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: 600psig.
9. Listing: Valve 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.

F. Bronze Plug Valves: MSS SP-78.

1. Body: Bronze, complying with ASTM B584.
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Operator: Square head or lug type with tamperproof feature where indicated.

5. Pressure Class: 125 psig.
6. Listing: Valve NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with “WOG” indicated on valve body.

G. Cast-Iron, Lubricated Plug Valves: MSS SP-78

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flowserve.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. McDonald, A.Y. Mfg. Co.
 - d. Milliken Valve Company.
 - e. Mueller Co.; Gas Products Div.
 - f. R & M Energy System, A Unit of Robbins & Myers, Inc.
2. Body: Cast Iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in “Underground Manual Gas Shutoff Valve Schedule” and “Aboveground Manual Gas Shutoff Valve Schedule” Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valve 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.

2.5 ELECTRICALLY OPERATED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Eclipse Combustion, Inc.
 - c. Goyen Valve Corp.; Tyco Environmental systems.
 - d. Magnatrol Valve Corporation.
 - e. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
 - f. Watts Regulator Co.; Division of Watts Water Technologies, Inc
2. Pilot operated.
3. Body: Brass or Aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless Steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.

7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

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 2 and smaller; flanged for regulators NPS 2 ½ and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - b. Invensys.
 - c. Equimeter.
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: 2 psig.

2.7 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 water stop, unless otherwise indicated.

2.8 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, provide products by one of 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.

2.9 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons. Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw. 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw. 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw, and chrome-plated finish.
- G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.10 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.

2.11 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured

for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural gas piping according to the international Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and the international Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with the international Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade, Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- D. Install fittings for changes in direction and branch connections.
- E. 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.
- F. 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.
- G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping
- B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- 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. Locate valves for easy access.
- G. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- H. Install piping free of sags and bends
- I. Install fittings for changes in direction and branch connections
- J. Install escutcheons at penetrations of interior walls, ceilings, and floors.
1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with

set screw.

- e. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements in Division 07 Section "Penetration Fire stopping."
- 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. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
- 1. Above Accessible Ceilings: Natural-gas piping, allowable fittings, valves, and regulators (properly vented to outside) may be installed in accessible ceiling spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-112 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quickset additives or cinder aggregate.
 - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require

striker barriers.

5. Prohibited Locations:

- a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- S. Connect branch piping from top or side of horizontal piping.
- T. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- U. Do not use natural gas piping as grounding electrode.
- V. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- W. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.6 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 81.20.1.
 - 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 dry seal 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. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

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.

3.8 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.

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1 D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (gloss).
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (gloss).
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.13 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. For appropriate and approved installations down through masonry walls, corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping may be used.
 - 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping, larger than NPS 1 but smaller than NPS 3, 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.
- B. Aboveground, distribution piping, NPS 3 and larger, shall be:
 - 1. Steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, full-port, bronze ball valves with bronze trim
 - 3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim
 3. Bronze plug valve,
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

END OF SECTION 226313

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SECTION 230000 – HVAC SCOPE OF WORK

RELATED DOCUMENTS:

All drawings and specifications by AVG Architecture. Notice to Bidders, Instructions to Bidders, EEO-Ohio Administrative Code Rules, Agreement Between Owner and Contractor, General Conditions, Special Conditions, and the entire State of Ohio, Ohio School Facilities Commission contract requirements.

DESCRIPTION OF WORK:

The work of this Bid Package shall include the following disciplines:

1. Common Work Results for HVAC
2. Hydronic Piping Specialties
3. Meters and Gages for HVAC Piping
4. General Duty Valves for HVAC Piping
5. Hydronic HVAC Flow Control
6. Hangers and Supports for HVAC Piping and Equipment
7. Through Penetration Firestopping
8. Glycol Heat Transfer Fluid and Feed System
9. Mechanical Vibration Control
10. Identification for HVAC Piping and Equipment
11. Testing, Adjusting, and Balancing
12. Mechanical Insulation
13. Commissioning of Mechanical Systems
14. HVAC Direct Digital Controls
15. Variable Frequency Drivers
16. Sequence of Operations for HVAC Controls
17. HVAC Piping
18. Hydronic Pumps
19. Refrigerant Piping
20. HVAC Water Treatment
21. Low-Pressure Ductwork
22. Medium-Pressure Ductwork
23. Flexible Ductwork
24. Ductwork Accessories
25. Centrifugal HVAC Fans
26. Air Terminal Units
27. Diffusers, Registers, and Grilles
28. HVAC Gravity Ventilators
29. Exterior Wall Louvers
30. Roof Curbs
31. Breeching, Chimneys, and Stacks
32. Condensing Boilers
33. Refrigerant Condensing Units
34. Rotary Scroll Water Chiller
35. Air to Air Energy Recovery Equipment
36. Modular Indoor Air Handling Units
37. Computer Room Air Conditioners
38. Ductless Split System

- 39. Unit Heaters - Propeller
- 40. Cabinet Unit Heaters
- 41. Electric Unit Heaters

ELABORATION OF WORK:

Provide all labor, materials, equipment, tools, supplies, services, and perform all things necessary to complete all work in accordance with the Specifications Sections, Documents and Drawings indicated and requirements as described to complete the intended scope without limitation by the general description.

All products and procedures as described in the following sections.

Section 23 00 00- HVAC Scope of Work
Section 23 05 00- Common Work Results for HVAC
Section 23 05 16- Hydronic Piping Specialties
Section 23 05 19- Meters and Gages for HVAC Piping
Section 23 05 23- General Duty Valves for HVAC piping
Section 23 05 25- Hydronic HVAC Flow Control
Section 23 05 29- Hangers and Supports for HVAC Piping and Equipment
Section 23 05 30- Through Penetration Firestopping
Section 23 05 34- Glycol Heat Transfer Fluid and Feed System
Section 23 05 48- Mechanical Vibration Control
Section 23 05 53- Identification for HVAC Piping Equipment
Section 23 05 93- Testing, Adjusting, and Balancing
Section 23 07 00- Mechanical Insulation
Section 23 08 00- Commissioning of Mechanical Systems
Section 23 09 00- HVAC Direct Digital Controls
Section 23 09 10- Variable Frequency Drives
Section 23 09 93- Sequence of Operations for HVAC Controls
Section 23 21 13- HVAC Piping
Section 23 21 23- Hydronic Pumps
Section 23 23 00- Refrigerant Piping
Section 23 25 00- HVAC Water Treatment
Section 23 31 13- Low-Pressure Ductwork
Section 23 31 14- Medium-Pressure Ductwork
Section 23 31 15- Flexible Ductwork
Section 23 33 00- Ductwork Accessories
Section 23 34 16- Centrifugal HVAC Fans
Section 23 36 00- Air Terminal Units
Section 23 37 13- Diffusers, Registers & Grilles
Section 23 37 23- HVAC Gravity Ventilators
Section 23 37 25- Exterior Wall Louvers
Section 23 37 26- Roof Curbs
Section 23 51 00- Breeching, Chimneys, and Stacks
Section 23 52 22- Condensing Boilers
Section 23 62 00- Refrigerant Condensing Units
Section 23 64 26- Rotary Screw Water Chiller
Section 23 72 00- Air to Air Energy Recovery Equipment

Section 23 73 13- Modular Indoor Air Handling Units

Section 23 81 23- Computer Room Air Conditioners

Section 23 81 26- Ductless Split System

Section 23 82 39- Unit Heaters – Propeller

Section 23 82 40- Cabinet Unit Heaters

Section 23 83 33- Electric Unit Heaters

END OF SECTION 23000

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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Pipe and pipefittings.
- B. Dielectric fittings.
- C. N/A
- D. Piping specialties.
- E. Lintels
- F. Installation requirements common to piping systems and specification sections.
- G. Installation requirements common to equipment specification sections.
- H. Testing and repair.
- I. Final completion.
- J. Coordinating drawings
- K. Record drawings.
- L. Maintenance and operating manuals.
- M. Lubrication and packing.
- N. Training

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Submittal data is required for dielectric fittings, flexible connectors, mechanical sleeve seals, and piping specialties.

1.3 QUALITY ASSURANCE

- A. Any manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, physical space limitations, and capacities at no additional cost to the project.
- B. Materials and installation shall comply with requirements of governing regulations and controlling agencies.

- C. All materials used shall be finest grade of their kind and shall be new and in first-class condition when installed.
- D. Work done by the Contractor shall include the services of an experienced superintendent.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Piping and tubing shall include factory-applied end caps.
- B. All piping and tubing shall be elevated from grade for on site storage.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in the building structure during progress of construction.
- C. Coordinate installation sleeves and supporting devices with concrete and structural components.
- D. Coordinate connection of mechanical systems with underground and overhead utilities and services.
- E. Coordinate requirements for access panels and doors.
- F. Coordinate installation of identifying devices.

1.6 PROJECT CONDITIONS

- A. Mechanical support shall only be permitted at steel joist panel points.
- B. Any supplemental steel required for support between building structural members or for the reinforcement at roof openings shall be the responsibility of the Mechanical Contractor, and shall be coordinated with the G.C.
- C. All trades shall note areas of the project that utilize the ceiling area as a return air plenum. All material, cables, piping, etc. shall be suitable for plenum installations.

1.7 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year unless noted otherwise in other sections.

PART 2-PRODUCTS

2.1 PIPE AND PIPE FITTINGS

- A. Pipe threads shall meet ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- B. Pipe-flange gasket materials shall meet ASME B16.21, nonmetallic, flat, asbestos-free.
- C. Pipe Flanges
 - 1. Full face shall be Class 125, cast iron and cast-bronze material.
 - 2. Narrow face shall be Class 250, cast-iron and cast steel material.
- D. Flange bolts and nuts shall meet ASME B18.2.1.
- E. Solder filler materials shall meet ASTM B 32.
 - 1. Alloy Sn95 and Sn94 shall be used.
- F. Brazing filler materials shall meet AWS A5.8.
- G. Welding filler metals shall comply with AWS D10.12.
- H. Solvent materials shall meet standard solvent cement requirements.
 - 1. CPVC piping shall meet ASTM F 493.
 - 2. PVC piping shall meet ASTM D 2564. Include primer according to ASTM F 656.
 - 3. Plastic pipe seals shall meet ASTM F 477
 - 4. Flanged, ductile-iron gasket, bolts, and nuts shall meet AWWA C 110.

2.2 DIELECTRIC FITTINGS

- A. Fittings shall be zinc plated with a thermoplastic liner, rated for 250 degrees F maximum.

2.3 N/A

2.4 PIPING SPECIALTIES

- A. Piping sleeves shall be constructed of galvanized sheet metal or steel pipe. Steel pipe shall meet requirements of ASTM A 53, Type E, Grade A, Schedule 40. Sleeves for copper piping shall be of compatible material to prevent interaction of piping materials.
- B. Escutcheons shall be manufactured wall, ceiling, and floor plates, split-type, and of heavy chrome-plated construction.

2.5 LINTELS

- A. All Lintels associated with HVAC work shall be furnished and installed by Mechanical Contractor. Mechanical Contractor shall coordinate all opening requirements with the information provided on the Structural drawings, see "Lintel Size & Details".

2.6 FIRESTOPPING

- A. Firestop all HVAC/mechanical work as required for the project, refer to section 23 05 30.

PART 3-EXECUTION

3.1 MECHANICAL/PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Division 23 piping/ductwork sections specify unique installation requirements.
- B. Install components with pressure rating equal to or greater than system operating pressure.
- C. Install all piping and ductwork at right angles or parallel to the building walls. Diagonal runs are prohibited.
- D. Install piping and ductwork tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for panel removal.
- E. Install all piping specialties to meet manufacturers requirements.
- F. Install pipe sleeves at all wall penetrations.
 - 1. PVC pipe sleeves are not permitted.
 - 2. Do not install sleeves through structural members.
- G. Maintain fire rating at fire wall penetrations through the use of approved fire sealant materials installed in pipe sleeve.
- H. Install unions in piping 2 inch and smaller at final connection to each piece of equipment.
- I. Install flanges in piping 2-1/2 inch and larger adjacent to flanged valves and at final connections to equipment with flanged pipe connections.
- J. Valves shall never be installed with stems in less than horizontal position.

3.2 INSTALLATION REQUIREMENTS

- A. Contractor shall be governed by the Architectural, Mechanical, Electrical and Structural drawings, as well as drawings associated trades, in the installation of HVAC work. The location of the piping, equipment, ducts, etc. on the drawings is diagrammatic; indicated positions shall be subject to building construction and interferences with electrical work. Should difficulties prevent the installation of any part of the work as indicated, such shall be called to the attention of the Architect, who will determine locations and changes, and the Contractor shall install the work accordingly. The Architect reserves the right to make minor changes in the location of any part of the work up to the time of roughing-in without additional cost.
- B. Coordinate work to avoid interference of work indicated and to secure maximum headroom. Particular attention is directed to spaces such as Mechanical Equipment Rooms. Furnish complete, in place, all necessary offsets in piping, ducts, etc., as close as possible to ceilings, walls, columns, etc., so as to take up minimum amount of space.

Furnish and install all offsets, fittings, etc., required without additional expense to the Owner.

- C. All piping, ducts, etc. located in pipe spaces must be located to insure maximum accessibility. Where necessary to cross pipe spaces, crossings must be made near the floor or 6 ft. or more above floor.
- D. The specifications indicate special conditions to be adhered to in making the installation of all equipment; however, the Contractor shall also follow the specific instructions and directions furnished by the equipment manufacturer for the proper installation and connection of all individual equipment.
- E. All equipment shall be installed with full consideration of future maintenance. Equipment, which is installed such that it cannot be readily accessible for repair or maintenance shall be removed and installed correctly as the Architect, may direct to facilitate servicing.
- F. If equipment, other than that which the drawings were designed around, does not properly adapt itself to space allotted or lend itself readily accessible for repair or maintenance, this Contractor is responsible to provide additional access panels, pipe fittings, ductwork, etc. to insure same end results.
- G. Contractor shall take all measurements and determine all elevations at the building.
- H. In all cases where a device or part of the equipment is herein to in the singular number (such as diffuser), it is intended that such items as are required to complete the installing.
- J. Install equipment to facilitate service, maintenance, and repair or replacement of components.
- K. Maintain lubrication gaskets and packing during construction and assure that at time of acceptance by the Owner, equipment is in first-class operating condition.

3.3 TESTING AND REPAIR

- A. All piping and ductwork systems shall be thoroughly cleaned and flushed prior to final testing.
- B. Supply, return, and exhaust air ductwork systems shall be pressure tested to a minimum leakage rate as defined by the in-force edition of ASHRAE 90.1.
- C. Pressure testing shall be completed for the following piping systems:
 - 1. Heating water and chilled water.
 - 2. Refrigerant piping
- D. All testing must be witnessed and accurately recorded noting methods of testing, times, dates, and results.
- E. Any damage as a result of tests shall be repaired or damaged materials replaced at no cost to the Owner.

3.4 FINAL COMPLETION

- A. All work shall be cleaned prior to issuance of Substantial Completion.
- B. Retouch or repaint factory painted prime and finish coats where scratched or damaged.
- C. Deliver filters, belts, and equipment, as required by this Specification, to Owner and obtained signed receipts of delivery.
- D. Clean equipment, restore damaged materials, and leave the Work in acceptable condition.
- E. Remove all site tools, equipment, surplus materials and rubbish continuously at no additional cost to the Owner.
- F. Contractor shall submit written certificates warranting each item of equipment.

3.5 COORDINATION DRAWINGS

- A. Preparation of and coordination of the coordination drawings shall be the responsibility of the Prime HVAC contractor as follows:
 - 1. The HVAC Prime contractor shall do the coordination with all other sub trades to distribute and transfer the interim coordination CAD files, supervise the adjustments to each trade and provide the final set of coordinated drawings.
 - 2. Prime and each (General Trades) sub-contractor (Sheet-Metal, Piping, Plumbing and Fire protection) shall prepare his installation drawing. He shall then review all conflicts and coordinate with other trades to make proper adjustments for his work.
 - 3. Following final coordination each contractor shall provide his REVIT or CAD drawings to the HVAC contractor to produce a “working” set for the field and the owner.
- B. Prepare coordination drawings at a scale not less than 1/4” – 1’-0” and submit them to Architect. Coordination drawings shall be produced by CAD based software on “AutoCAD” vs. 2002 or higher or REVIT (BIM). Prepare and deliver one set of electronic media of the coordination drawings for owner’s use.
- C. Coordination drawings to show relation of all items of heating, ventilating and air conditioning equipment, ductwork and piping, plumbing equipment and piping and Fire Protection. Also, to be shown are such items of electrical systems which affect location of heating, ventilating, air conditioning and plumbing equipment, piping, ductwork and air outlets. Show existing items affecting new installation at remodeled areas.
- D. Provide coordinated set of wiring diagrams for motors, equipment items and temperature control, showing line diagrams, power diagrams and terminal connections to ensure proper operation of mechanical systems and to conform to system operation specified. Include provisions to accommodate equipment which is specified as acceptable equipment manufacturer but is not specified as base of design, so that if the other equipment is accepted, there will be no change in the Contract Sum.
- E. Secure approval of coordination drawings from other trades affected, prior to submittal to

architect. Each trade must indicate acceptance of illustrated conditions by attaching his endorsement to each drawing.

- F. Contractors for other trades (Acoustical Ceiling, Electrical, etc.) will provide Mechanical Contractor with necessary and sufficient information and/or drawings as required and/or as requested by Mechanical Contractor to permit development of coordination drawings. This information shall include but is not limited to the following:
 - 1. Framing and suspension details for ceilings.
 - 2. Location and size of electrical pull boxes, conduit, bus ducts, lighting fixtures, etc.
- G. Issue copies of coordination drawings through General Contractor to all other contractors concerned and obtain their agreement and approval prior to submittal to Architect.
- H. Proceed with installation only after review and approval by other trades affected.

3.6 RECORD DRAWINGS

- A. The Contractor shall keep a running record of each change and deviation from the Drawings on a clean and undamaged set of Drawings.
- B. The final Project Record Drawings shall be submitted to the Architect for approval at the completion of the project.
- C. Record Drawings shall include the location of concealed piping, ductwork, valves and dampers.

3.7 MAINTENANCE AND OPERATING MANUALS

- A. The Maintenance and Operating Manuals shall comply with other Sections of this Specification. Submit in triplicate for inclusion in Maintenance and Operating Manuals.

3.8 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for the required amount of hours per the individual specification. A minimum of four (4) hours shall be required where not specified. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present the required number of copies per the individual specification of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 230500

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SECTION 230516 - HYDRONIC PIPING SPECIALTIES

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Piping expansion joints (compensators & expansion loops) and piping guides.
- B. Pressure reducing valves
- C. ASME safety relief valves
- D. Manual and automatic air vents.
- E. ASME compression and expansion tanks
- F. Air separators with automatic air vent
- G. Strainers
- H. Pump suction fitting

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. Pressure piping shall meet ASME B31.9 Code.
- B. Safety relief valve requirements shall meet ASME Boiler and Pressure Vessel Code.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 EXPANSION JOINTS

- A. Expansion Compensator:
 - 1. Manufacturers:
 - a. Keflex Model 7QT
 - b. Flexonics Model H
 - c. Metraflex Model HP.
 - d. Twin City Hose
 - 2. Body: Steel

3. Working Pressure: 125 psi.
4. Maximum Temperature 250 degrees F
5. Maximum Compression 1 ½ inch
6. Maximum Elongation ½ inch
7. Joint: Copper Sweat End
8. Size: Used pipe size units.
9. Application: Copper piping 2 inch and under.

B. Pipe Alignment Guidelines:

1. Manufacturers:
 - a. Keflex.
 - b. Flexonics.
 - c. Metraflex.
2. Two-piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

C. Grooved End Expansion Joints

1. Packless, gasketed, slip-type expansion joint with grooved end telescoping body for installation with Style 07 rigid couplings, providing up to 3 inch axial end movement. Designed for service up to 230° F and for working pressures up to 350 psi.
2. Combination of Style 75 or 77 flexible couplings and grooved end short nipples joined in tandem to provide increased expansion. Joint movement and expansion capabilities determined by number of couplings/nipples used in the joint. Designed for service up to 230° F. Pressure rating dependent on size and style of flexible couplings used.

2.2 EXPANSION LOOPS (V & U CONNECTORS)

A. Expansion Compensator V & U Connectors:

1. Manufacturers:
 - a. Twin City Hose
 - b. Flex-Weld
 - c. Metraflex Metraloop
 - d. Engineered Flexible Products

B. When indicated on drawings, use flexible thermal V and U connectors of the size, type and end fittings noted. V and U connectors allow movement along the 6 planes of the X, Y and Z axis. Movements are primarily in lateral directions, minimizing weld attachment stress.

C. In expansion compensation situations, the V and U connector can be installed pre-compressed or pre-extended, only if the full range of motion will be encountered in only one direction. Larger connectors are supplied with shipping bars attached. These bars are tack welded on to maintain the proper designed length. The shipping bars need to be removed from the V or U after installation.

- D. Anchors are required on either side of the V or U connector to react to the spring forces of the connector. Pressure thrust loads are not a consideration because the V or U connector will not impose pressure thrust onto the system. Anchors should be of sufficient strength to withstand the spring forces of the loops and the frictional forces of the pipe sliding through any pipe alignment guides.

2.3 PRESSURE-REDUCING VALVES

- A. Bronze or cast iron body with inlet strainer and non-corrosive valve seat and stem. Preset at 12 psig (adjustable).

2.4 ASME SAFETY-RELIEF VALVES

- A. Manufacturers:
 - 1. Kunkle
 - 2. Bell & Gossett
 - 3. McDonnell Miller
 - 4. Watts
- B. Brass or bronze body with brass and rubber wetted internal working parts. Size for the pressure and capacity of the system.

2.5 MANUAL AIR VENTS

- A. Provide 1/2 inch diameter piping loop with ball valve and standard hose end connection.

2.6 AUTOMATIC AIR VENTS

- A. High capacity with float operation. Constructed of cast iron body with stainless steel, brass and EPDM internal parts. Rated for 250 degrees F at 150 psig. Unit shall be designed not to allow air into the vent in case of system pressure dropping below atmospheric pressure. Use for relieving air from the system at the air separator only.
 - 1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a) Armstrong Pumps, Inc.
 - b) Bell & Gossett Domestic Pump.
 - c) Nexus Valve, Inc.
 - d) Taco, Inc.
 - 2) Body: Bronze or cast iron.
 - 3) Internal Parts: Nonferrous.
 - 4) Operator: Noncorrosive metal float.
 - 5) Inlet Connection: NPS 1/2.
 - 6) Discharge Connection: NPS 1/4.
 - 7) CWP Rating: 150 psig.
 - 8) Maximum Operating Temperature: 240 deg F.

2.7 EXPANSION TANKS

- A. Manufacturers:
 - 1. Taco

2. Bell & Gosset
 3. Armstrong
- B. Shall be type CA as manufactured by Taco, Bell & Gosset or Armstrong of heavy duty, BUTYL rubber bladder tank allows permanent separation of air and water within the ASME designed and constructed pressure vessel. Tank shall be designed for 125 PSIG water pressure. Provide tank for each closed loop system.

2.8 AIR & DIRT SEPARATORS

- A. Manufacturers:
1. Taco.
 2. Bell & Gosset
 3. Spirotherm
- B. Furnish and install air and dirt removal devices of the size and type as shown on the plans. Air and dirt separation devices shall be Taco model 4900 series of size and capacities noted on drawings.
- C. Air and dirt removal devices shall be constructed of steel design and fabricated per ASME Section VIII Division I with a maximum working pressure rating of 125 psi at 270° F. Units up to 3-inch in size shall be provided with a threaded system connection. Units 4-inch and larger shall be provided with a flanged system connection as standard.
- D. Each air and dirt separator shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and the removal of floating impurities from the air system interface within the separator. A blowdown valve shall be provided by the unit manufacturer on the bottom of each air/dirt separator to allow cleaning as required.
- E. The air and dirt separator shall employ the use of high surface pall rings to achieve optimal separation of gas and dirt. The supplier of the air and dirt separator shall furnish to the design engineer the results of independent air and dirt testing of a representative unit from the supplier standard product offering. Suppliers not providing these independent performance test results will not be accepted.

2.9 STRAINERS

- A. Size 2 inch and Under:
1. Manufacturers:
 - a. Mueller
 - b. Grinnell
 - c. Fisher
 - d. Victaulic
 - e. Nexus
 2. Screwed brass or iron body for 150 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- B. Size 2-1/2 inch to 4 inch:
1. Manufacturers:

- a. Mueller
 - b. Grinnell
 - c. Fisher
 - d. Victaulic
 - e. Nexus
 - 2. Flanged iron body for 150 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- C. Size 5 inch and Larger:
- 1. Manufacturers:
 - a. Mueller
 - b. Grinnell
 - c. Fisher
 - d. Victaulic
 - e. Nexus
 - 2. Flanged iron body for 150 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen

2.10 PUMP SUCTION FITTINGS

- A. Manufacturers:
- 1. Taco
 - 2. Bell & Gosset.
 - 3. Armstrong.
 - 4. Victaulic
- B. Fitting: Angle pattern, cast iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh start-up strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning. Size to be as noted on drawings.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connection or apparatus.
- B. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offset, and swing joints, or expansion joints where indicated.
- C. Provide expansion loops as indicated on drawings.
- D. Provide pressure reducing valves at the domestic cold water make-up connection to the closed loop heating and chilled water piping systems.
- E. Provide ASME safety relief valve in all closed hydronic loop systems. Relief valves shall

be sized for the proper relief capacity to protect each system.

- F. Provide manual air vent valves at all coils and at the high points of each system.
- G. Provide automatic air vent valves on the air separator for each system. Pipe this air relief discharge to the nearest floor drain.
- H. Provide an ASME bladder type expansion tank for each closed loop system.
- I. Provide a full size (size, capacity and standard velocity) centrifugal air and dirt separator on the suction side of each closed loop pumping system. The capacity shall meet or exceed the flow requirements of the system.

END OF SECTION 230516

SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Thermometers and fittings.
- B. Pressure gauges and fittings.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting materials, sizes, and dimensions.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Trerice
- B. Ashcroft
- C. Weiss

2.2 COMPONENTS

- A. Thermometers: 1-percent accuracy.
 - 1. Glass type: Mercury filled 9- inch long industrial type.
 - 2. Direct-Mounting Filled-System Dial Type: Vapor actuated, thermal bulb, precision brass gear.
 - 3. Remote-Reading, Filled-System Dial Type: Vapor actuated, thermal bulb, precision brass gear.
 - 4. Bimetal Dial Type: Direct mounting, bimetal coil.
 - 5. Insertion Dial Type: Bimetal coil.
- B. Pressure Gauges: Phosphor-bronze Bourdon-tube gages, 1-percent accuracy.
 - 1. Vacuum Range: 30 inches Hg of vacuum to 15 psig of pressure.
 - 2. Pressure Range: Two-times operating pressure.

PART 3-EXECUTION

3.1 INSTALLATION

A. Provide thermometers at the following locations:

1. Inlet and outlet chilled water connection to each chiller.
2. Inlet and outlet heating water connections to each boiler.
3. Heating water, and chilled water supply and return loop to and from the building if primary/secondary pumping is used or if a 3-way valve is used to reset the building heating water temperature.
4. At all coil connections at main air handling units.
6. As otherwise shown on drawings.

B. Provide pressure gauges at the following locations:

1. One pressure gauge with 2 independent needle valves piped to the suction and discharge piping of all pumps except coil recirculating pumps.
2. Inlet and outlet piping of each chiller.
3. Outlet piping of each boiler unless integral to the boiler.
4. Domestic cold- water fill connection to the HVAC hydronic loop downstream of the pressure reducing valve.
5. As otherwise shown on drawings.

END OF SECTION 230519

SECTION 230523 - GENERAL DUTY VALVES FOR HVAC PIPING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Valves

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Shop drawings shall include product data noting type materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. The following standards apply.
 - 1. ANSI B16.10, MSS SP-67-90 Butterfly Valves.
 - 2. MSS SP-78-92 Cast Iron Plug Valves Flanged and Threaded.
 - 3. MSS SP-80-87 Bronze Globe, and Check Valves.
 - 4. N/A
 - 5. MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

PART 2-PRODUCTS

2.1 COMPONENTS

- A. Ball Valves
 - 1. Manufacturers:
 - a. Hammond
 - b. Apollo
 - c. Milwaukee
 - d. Victaulic
 - 2. Bronze body and bonnet, two-piece construction, chrome-plated ball, standard port for 2-1/2 - inch NPS and smaller and full port for 3-inch NPS valves, Class 150, with stem extensions for insulated piping and memory stops.
 - 3. Ductile-iron grooved end body, two-piece construction, chrome-plated carbon steel ball and stem, standard port, TFE seats and Fluoro elastomer seals, lever handle or gear operator, 800 psig CWP. Victaulic Series 726.

B. Plug Valves

1. Manufacturers:
 - a. Hammond
 - b. Apollo
 - c. Milwaukee
 - d. Victaulic
2. Cast-iron body and bonnet, cast-iron plug, 175 psig, with lever operator.
3. This valve is only used for gas systems.
4. Grooved end eccentric type plug valves with ductile iron body and elastomer coated ductile iron plug, 175 psig with lever handle or gear operator. This valve shall only be used for water systems with a maximum operating temperature of 230 degrees F. Victaulic Series 377.

C. Globe Valves

1. Manufacturers:
 - a. Hammond
 - b. Apollo
 - c. Milwaukee
 - d. Victaulic
2. 2-1/2 Inch NPS and Smaller: Cast-bronze body and bonnet, Class 125 or 150, with threaded or soldered connections.
3. 3 Inch NPS and Larger: Cast-bronze body and bonnet, Class 125, outside screw and yoke, with flanged connections.

D. Butterfly Valves: Cast-iron body and bonnet, Class 250, 200 psig working pressure, stainless-steel stem; lug, or grooved style connections. (For HVAC systems only).

1. Manufacturers:
 - a. Hammond
 - b. Apollo
 - c. Milwaukee

- d. Victaulic
- 2. Disc Type: Aluminum bronze
- 3. Grooved end butterfly valve with ductile iron body and nickel-coated ductile iron disc, 300 psig working pressure, offset disc to provide continuous 360 degree seating. Victaulic Vic – 300 Master Seal.
- 4. Operator:
 - a. Standard lever handle.
 - b. Standard lever handle with memory stop.
 - c. Lever handle with latch lock.
 - d. Gear with position indicator.
 - e. Gear with position indicator and chain wheel.
 - f. Chain wheel
- E. Check Valves
 - 1. Manufacturers:
 - a. Hammond
 - b. Apollo
 - c. Milwaukee
 - d. Victaulic
 - 2. Swing Type, 2-1/2 Inch NPS and Smaller: Bronze body, Class 125 or 150, horizontal swing, with threaded or soldered connections.
 - 3. Swing Type, 3 Inch NPS and Larger: Cast-iron body, Class 125, horizontal swing, with flanged or grooved connections.
 - a. Wafer Type: Class 125, cast-iron body, bronze disc, with stainless-steel pins and springs.
 - b. Lift Type: Class 125, bronze body and cap, horizontal or vertical pattern, bronze disc, with threaded or soldered connections.
 - c. Grooved End Swing Type: 300 psig, ductile iron body, horizontal swing, 316 stainless steel clapper with EPDM bonded bumper. Victaulic Series 712.
 - d. Grooved End Spring-Loaded Type: 300 psig, ductile iron body aluminum bronze or elastomer coated ductile iron disc, stainless steel spring and shaft,

PPS coated or welded-in nickel seat. Victaulic Series 716.

PART 3-EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges, Victaulic couplings, or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

3.2 INSTALLATION

- A. Install all threaded valves with a union joint on the downstream side of the valve.
- B. Provide valves to isolate all equipment and coils on the supply and return pipes.
- C. Provide valves of like material as the piping systems.
- D. Provide dielectric waterway connections between all dissimilar metals.
- E. Install valves with stems upright or horizontal not inverted.
- F. Grooved end valves shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. To assure uniformity and compatibility all grooved end valves and adjoining couplings shall be supplied by Victaulic. Grooved end shall be clean and free from indentations and projections. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved end valves. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

END OF SECTION 230523

SECTION 230525 - HYDRONIC HVAC FLOW CONTROL

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Calibrated plug valves for manual system flow balancing.
- B. Automatic flow balancing valves.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawing shall include product data noting materials, sizes, and dimensions.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. IMI-FDI.
- B. Tour and Anderson
- C. Griswold
- D. Nexus Valve (Coil packages)
- E. Red White Valve Corporation

2.2 CALIBRATED PLUG VALVES

- A. 125 psig maximum working pressure 250 degrees F maximum operating temperature, bronze construction with calibrated orifice. Provide with pressure temperature taps. Two inches diameter and smaller shall have threaded connections. Two and one-half inches diameter and larger shall be flanged connections.

2.3 AUTOMATIC FLOW BALANCING VALVES

- A. 150 psig maximum working pressure, 250 degrees F maximum operating temperature. Brass or bronze housing for one and one-half inches diameter piping size and smaller and cast iron for two inches diameter and larger piping size with all stainless- steel operating parts. Flow shall be controlled to plus or minus 5 percent of the required flow. Provide with threaded connections for two inches diameter and smaller. Provide flanged or grooved connections for two inches diameter and larger. Provide with pressure temperature taps on each side of the flow control cartridge. Provide the proper pressure control range for the system.
- B. Pressure-compensating flow control valves in a union-ball-valve/flow-control-device one- piece configuration. Valve are to be installed on hot water heating, chilled water piping, downstream lines, as shown on drawings. Balancing valve on supply side is

unacceptable. Ball valve shall have screwdriver slot. These valves shall have range ability in flow requirements:

1. All valves are to be pre-set to control the flow rate within 5% of the tagged rating over an operating pressure differential of at least ten times the minimum required for full flow conditions.
 2. The valves shall be all metal with thread or sweat connections and shall be all brass and stainless steel.
 3. Performance certification of valves by an independent laboratory shall be available.
 4. All valves shall have access capability to allow field-exchange of internal components without removing valve body from pipeline.
 5. All valves shall be permanently marked to show direction of flow, flow rate, and pressure range.
- C. Provide an IMI-FDI. Tour & Anderson or Griswold, in-line strainer for each automatic flow control valve furnished. Strainer to be in a union-ball-valve/strainer one-piece configuration. These strainers shall have screening capacities and meet the following requirements:
1. All strainers shall be able to limit passage of particulate matter more than 510 microns, shall be all brass and stainless steel with threaded or sweat connection, and shall have blow-down valve attached to allow purging, directly through accessory valving.
 2. All strainers shall be permanently marked to show direction for flow.
- D. Pressure and Temperature Test Stations
1. Furnish as a part of each flow control valve and strainer valve by IMI-FDI. or Griswold, a Pete's Plug Model #110XL 1/4" MPT fitting to receive either temperature or pressure probe. Fitting shall be solid brass with two valve cores of Nordel. Single valve core unit Unacceptable.
 2. In addition, this Contractor shall present to the Owner upon completion of testing a Model 1500XL – test kit consisting of a 0-100 PSIG (0-230' water pressure gauge with 500 XL adaptor and two pocket testing thermostats.
 3. Pressure and temperature test stations

PART 3-EXECUTION

3.1 INSTALLATION

- A. Provide automatic flow control valves at each Air Handling Unit Coil, VAV box coil, fan powered VAV box coil, chiller, each boiler of a multiple boiler installation, cabinet unit heaters, unit heaters and anywhere else indicated on drawings or details, to properly balance the flow to each device.

END OF SECTION 230525

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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Pipe, duct and equipment hangers, supports and associated anchors.
- B. Equipment bases and supports.
- C. Sleeves and seals.
- D. Flashing and sealing equipment and pipe stacks.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings are required and shall include product data noting materials, sizes, and types.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. PHD
- B. Carpenter and Paterson
- C. Anvil/Grinnell

2.2 PIPE HANGERS AND SUPPORTS

- A. Hangers, supports, and components shall be factory fabricated according to MSS SP-58, the latest edition.
- B. Hangers for piping shall be of a compatible material or coating.
- C. Continuous threaded rod shall be used wherever possible. Chain, wire, or perforated straps shall not be permitted.
- D. Concrete inserts into poured concrete floor systems are not permitted.
- E. Supports from roof decking systems are not permitted.
- F. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring, and insulation saddle.
- G. Hangers for Pipe Sizes 2 to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Carbon steel, adjustable, clevis, and insulation saddle.

- H. Multiple of Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- I. Wall Support for Pipe Sizes 3 Inches: Carbon steel.
- J. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- K. Vertical Support: Steel riser clamp.
- L. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- M. Copper Pipe Support: Carbon steel ring, adjustable, copper plated or plastic coated.
- N. Piping Across Roof: Install on Pate (or equal) equipment support rails with roller supports, all suitable for outdoor installation.

2.3 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.4 INSERTS

- A. Inserts: Malleable iron, case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-Fire Rated Floors: Form with 18 gage galvanized steel.
- B. Sleeves for Pipes Through Non-Fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Form with steel pipe or 16 gage galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Form with galvanized steel.
- E. Sleeves for Rectangular Ductwork: Form with galvanized steel.
- F. Stuffing or Fire Stopping Insulation: Glass fiber type, non-combustible.

2.6 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported piping.

2.7 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed. Apply two coats of primer and two coats of epoxy to hangers and supports outdoors.

2.8 SPRING HANGERS

- A. All ductwork, equipment, water piping, refrigerant piping, coils, VAV boxes, constant volume controllers and condensate drains running thru or above sound critical rooms is to be supported with spring isolators as a part of the hangers. All new refrigerant piping in building is to be hung with spring hangers.

2.9 DUCTWORK SUPPORTS

- A. Supports for ductwork with lagging to be selected to support entire weight of duct and lagging

PART 3-EXECUTION

3.1 PIPE HANGERS & SUPPORTS

- A. All hangers and supports shall be attached to the building structural steel system.
- B. Support from steel joist panel point is required.
- C. Support horizontal piping as follows:

	Spacing	Rod Size
1/2 to 1-1/4 inch	6'-6"	3/8"
1-1/2 to 2 inch	10'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
4 to 6 inch	10'-0"	5/8"
PVC - 3/4 to 1 inch	4'-0"	3/8"
PVC - 1-1/4 to 1-1/2 inch	4'-0"	3/8"
PVC - 2 to 2-1/2 inch	4'-0"	3/8"
PVC - 3 to 4 inch	4'-0"	1/2"

- D. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
- E. Place a hanger within 12 inches of each horizontal elbow.
- F. Use hangers with 1-1/2 inch minimum vertical adjustment.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping. Support vertical pipe per code.

3.2 EQUIPMENT BASES AND SUPPORTS

- A. Construct equipment supports of steel angles. Brace and fasten with flanges bolted to structure.

3.3 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Extend sleeves through floors one inch above finished floor level. Caulk sleeves full depth and provide floor plate.
- C. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing or fire stopping insulation and seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- D. Install chrome plated steel escutcheons at finished surfaces.

END OF SECTION 230529

SECTION 230530 - THROUGH PENETRATION FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Penetrations through fire-resistance-rated vertical assemblies.
 - 2. Penetrations through fire-resistance-rated horizontal assemblies.
 - 3. Penetrations through smoke barriers and smoke partitions.
- B. Related Sections
 - 4. Division 1 – General Requirements.
 - 5. Division 3 – Concrete.
 - 6. Division 4 – Masonry.
 - 7. Division 7 – Thermal and Moisture Protection.
 - 8. Division 9 – Finishes.
 - 9. Division 22 – Plumbing.
 - 10. Division 23 – Heating Ventilating and Air Conditioning.
 - 11. Division 26 – Electrical.
 - 12. Division 27 – Communications.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI/UL 263 - Fire Tests of Building Construction and Materials.
 - 2. ANSI/UL 723 - Surface Burning Characteristics of Building Materials.
 - 3. ANSI/UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Firestops.
 - 4. ASTM E 2174 - Standard Practice for On-Site Inspection of Installed Firestops.
- C. Factory Mutual (FM) - FM4991 - Standard for Approval of Firestop Contractors.
- D. International Code Congress (ICC):
 - 1. International Building Code (IBC).
 - 2. International Residential Code (IRC).
 - 3. International Mechanical Code (IMC).
 - 4. International Fire Code (IFC).
 - 5. International Code Congress Evaluation Service (ICC ES).
- E. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
 - 3. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
 - 4. NFPA 101 - Life Safety Code.
 - 5. NFPA 5000 – Building Construction and Safety Code.

- F. Underwriters Laboratories (UL) - UL Building Materials Directory:
 - 1. Through-Penetration Firestops Systems (XHEZ).
 - 2. Firestop Devices (XHJI).
 - 3. Forming Materials (XHKU),
 - 4. Wall Opening Protective Materials (CLIV).
 - 5. Fill, Void or Cavity Materials (XHHW).
- G. American Society of Sanitary Engineering (ASSE):
 - 1. ASSE Series 9000 – Professional Qualification Standard for Firestop Systems and Device Installers, Inspectors and Surveyors.
- H. International Association of Plumbing and Mechanical Officials (IAPMO):
 - 1. Uniform Plumbing Code (UPC).
 - 2. Uniform Mechanical Code (UMC).
- I. International Standards Organization (ISO):
 - 1. ISO 6944.
 - 2. ISO 10295-1: 2007.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide systems that are listed by at least one the following:
 - 1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory".
 - 2. Intertek Testing Service (Formerly known as Omega Point Laboratories), in "Directory of Listed Products".
 - 3. Factory Mutual (FM), in FMRC Approval Guide.
 - 4. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.
- B. Provide firestop products that are flexible enough to allow for pipe vibration in a through penetration application.
- C. Provide products with the appropriate flame spread index and smoke develop index, when tested in accordance with ASTM E 84.
- D. Provide products identical to those tested and listed for classification by UL, Intertek or any other qualified independent testing agency.
- E. Provide products that bear classification marking of qualified independent testing agency.
- F. Where firestop systems not listed by any listing agency are required due to project conditions, submit a substitution proposal with evidence specified.
- G. Use only products specifically listed for use in listed systems.
- H. Provide products that are compatible with each other, with the substrates forming openings, and with the items, if any, penetrating the firestopping, under the conditions represented by this project, based on testing and field performance demonstrated by manufacturer.
- I. Firestopping materials must meet and be acceptable for use by all applicable codes cited in this section.
- J. Provide products that meet the intent of the state or local and LEED ® guidelines on volatile organic compounds (VOC).

- K. Where applicable provide products that meet the intent of the F rating classification for passage of flame per ASTM E 814 or ANSI/UL 1479 for through penetrations.
- L. Where applicable provide products that meet the intent of the T rating classification for the transfer of temperature per ASTM E 814 or ANSI/UL 1479 for through penetrations.
- M. Where applicable provide systems that meet the intent of the L rating classification for the movement of smoke per ANSI/UL 1479 for through penetrations.
- N. Where applicable provide products that meet the intent of the W rating classification for passage of water per ANSI/UL 1479 for through penetrations.

1.4 SUBMITTALS

- A. Submit under provisions of the Contract and Division 01 – General Requirements.
- B. Shop Drawings: For each firestopping system, provide the following:
 - 1. Listing agency's detailed drawing showing opening, penetrating item(s), and firestopping materials, identified with listing agency's name and number or designation and fire rating achieved.
 - 2. For proposed systems that do not conform strictly to the listing, submit written instructions showing modifications and approved by firestop system manufacturer.
 - 3. Submit under provisions of the International Building Code (IBC) section 703 requiring a submittal package for fire-resistance ratings and fire tests.
- C. Product Certificates: Submit certificates of conformance signed by firestop system manufacturer certifying that materials furnished comply with requirements.
- D. Product Data: Furnish manufacturer's product data sheets on each material to be used in firestop systems. Information on manufacturer's product data sheet should include:
 - 1. Product characteristics including compliance with appropriate ASTM/UL/ANSI test standards.
 - 2. Storage and handling requirements and recommendations.
- E. Installation Instruction: Furnish manufacturer's installation instructions.

1.5 Sustainable or LEED Submittals:

1.6 VOC Content: For sealants and sealant primers, furnish documentation of VOC content.

1.7 QUALITY ASSURANCE

- A. General: All through-penetration firestop systems shall be installed with approved methods using materials that have been tested and classified to produce an approved assembly.
- B. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of Twenty five (25) Years experience in passive fire protection.
 - 1. Products shall be manufactured in a facility that follows ISO 9001 best practices.
 - 2. Products shall have undergone a formal life cycle assessment evaluating environmental impact.
- C. Installer Qualifications: Firm must be qualified by having experience, staff, and be properly trained to install the specified products, and meets the following criteria:

1. Contractor is acceptable to manufacturer.
 2. Contractor is acceptable to Authority Having Jurisdiction (AHJ).
 3. Contractor has completed the manufacturer's certified product installation training.
 4. Contractor must provide a list of completed projects as evidence of experience; include project name and address, owner's name and address, and architect's name and phone number.
 5. Certificate: Contractor should provide certificate of qualification.
- D. Codes: Where manufacturer's application procedures are in conflict with those of the local Authority Having Jurisdiction, the more stricter guidelines will prevail.
- E. Pre-installation Meetings: Meetings to agree on firestop requirements, conditions, manufacturer's instructions.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products until ready for installation in manufacturer's original unopened packaging, legibly marked with manufacturer's name and product identification, date of manufacture, lot number, listing agency's classification marking, curing/dry time, and mixing instructions (if applicable) and MSDS reference number.
- B. Store and handle in such a manner as to prevent deterioration or damage due to moisture, temperature changes, contaminants, and other causes; follow manufacturer's instructions.
- C. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local Authority Having Jurisdiction (AHJ).

1.9 PROJECT CONDITIONS

- A. Coordinate construction and cutting of openings so that each particular firestop system may be installed in accordance with its listing, including sizing, sleeves, and penetrating items, L rating and manufacturer's published STC rating.
- B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install firestopping under environmental conditions outside manufacturer's absolute limits.
- C. Provide ventilation as required by firestopping manufacturer, including mechanical ventilation if required.

1.10 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: 3M Fire Protection Products
- B. Hilti Firestop Products

C. STI Firestop

Single Source: To maintain control and integrity of the firestop applications a single manufacturer should be used. Specific UL or approved listing agencies systems applicable to each type of firestop condition should be supplied by one manufacturer.

2.2 SCOPE/APPLICATION

- A. Provide installed firestop products that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations, restoring the integrity of the fire rated construction to its original fire rating.
- B. Provide firestop systems listed for the specific combination of fire-rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:
 - 1. F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
 - 2. T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on exposed side(s) of rated assembly, T-rating must equal its F-rating.
 - 3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures. For those applications that require air leaking protection.
 - 4. W-Rating meets UL Water Leakage Test, W Rating – Class 1 requirements for systems tested and listed in accordance with ANSI/UL 1479.
 - 5. Wall Penetrations: Through penetration systems must be symmetrical, with the same rating from both sides of the wall. Membrane penetrations may be asymmetrical.
 - 6. Testing: Determine ratings in accordance with ASTM E 814 or UL 1479.

2.3 THROUGH PENETRATION FIRESTOP PRODUCTS

- A. 3M Fire Barrier Cast-in-Place Devices: Firestopping device for use prior to a concrete pour. Adjustable height with pull tabs, straight edge design for close placement to walls and adjacent devices.
 - 1. Fire Resistance: For use in 1, 2, or 3 hour fire-rated systems.
 - 2. Locations: Horizontal assemblies only.
- B. 3M Fire Barrier Ultra RC Pack: One piece metal collar assembly encasing intumescent material for firestopping of pipes and cables through rated walls and floors.
 - 1. Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- C. 3M Fire Barrier Ultra Plastic Pipe Device: Intumescent device for firestopping of plastic pipe and cables through rated walls and floors.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Configuration: One-piece metal collar, with locking latch and bendable tabs to secure; equipped also for conventional anchoring.
 - 3. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- D. 3M Fire Barrier RC-1 Restricting Collar with either FS 195+ Wrap Strip or 3M Interam Ultra GS Wrap Strip. (See product descriptions below): For firestopping of plastic pipes from 4 inches (102 mm) to 10 inches (254mm) in diameter.
 - 1. Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 - 2. Material: 28 gauge steel.
 - 3. Size: 25 foot (7.6 m) roll.

4. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- E. 3M Fire Barrier CP25WB+ Sealant: High-performance, intumescent, water-based sealant. No-sag, fast drying, paintable, red in color. Versatile firestop sealant for pipes (not for use with CPVC), cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- F. 3M Fire Barrier IC 15WB+ Sealant: General-purpose, intumescent, water-based sealant. No-sag, fast drying, paintable, yellow in color. Economical firestop sealant for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- G. 3M Fire Barrier Sealant FD 150+: Single-part, water-based, acrylic latex sealant. No-sag, low-shrinkage, low VOC. Blue, red or limestone color. Used to firestop for pipe penetrations (not for use with CPVC).
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 54 when tested in STC 54-rated wall assembly.
- H. 3M Fire Barrier Water Tight Sealant 3000 WT: Single-part, water-tight, intumescent silicone firestop sealant for filling voids in concrete gypsum, metal, plastic, wood and insulation. Light gray color with black flecks. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 53 when tested in STC 54-rated wall assembly.
- I. 3M Fire Barrier Water Tight 1000 NS Sealant: Single-part, non-slump firestopping silicone sealant for floor and wall openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 3. STC rating of 56 when tested in STC 56-rated wall assembly.
- J. 3M Fire Barrier Water Tight Sealant 1003 SL: Single-part, self-leveling firestopping silicone sealant for floor openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 2. Locations: For horizontal assemblies only.
 3. STC rating of 56 when tested in STC 56-rated wall assembly.
- K. 3M Fire Barrier Sealant 2000 NS: Single-part, non-slump elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit and electrical wiring.

1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical and horizontal assemblies.
 3. STC-Rating of 56 when tested in STC 56-rated wall assembly.
- L. 3M Fire Barrier Sealant 2000+: Single-part, elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit and electrical wiring.
1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 2. Locations: Vertical and horizontal assemblies.
 3. STC-Rating of 56 when tested in STC 56-rated wall assembly.
- M. 3M Fire Barrier Moldable Putty+: One-part, 100 percent solids intumescent firestop. Remains pliable, flexible and easily re-enterable. Non-toxic synthetic formula. Versatile putty for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
1. Type: Stick or Pad
 2. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 3. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- N. 3M Fire Barrier 2001 Silicone RTV Foam: Two-part, liquid-silicone elastomer, foams in place when mixed. For use sealing large or complex openings such as cable bundles and cable trays.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- O. 3M Fire Barrier Mortar: For sealing openings in concrete and masonry walls and floors. Self Leveling, non-sag, low VOC.
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- P. 3M Fire Barrier Self-Locking Pillow: Self-contained, intumescent firestop pillow with interlocking strips. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
1. Fire Resistance: For use in 1, 2 or 3 hour, fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- Q. 3M Fire Barrier Pillow: Self-contained, intumescent firestop product. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- R. 3M Fire Barrier CS-195+ Composite Sheet: Organic/inorganic intumescent elastomeric sheet, bonded on one side to a layer of 28 gauge galvanized steel. Other side reinforced with steel-wire mesh and covered with aluminum foil. Re-enterable. For use in firestopping larger openings
1. Thickness: Nominal 0.3 inch (7.6 mm).
 2. Thermal Expansion: 8 - 10 times original size.
 3. Tensile Strength (ASTM D412): 93.6 psi (645 kPa)/489 percent.
 4. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 5. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

- S. 3M Interam Ultra GS Wrap Strip: Graphite based, flexible, largely inorganic, intumescent mat. For use around non-metallic piping with or with RC-1 collar.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- T. 3M Fire Barrier FS-195+ Wrap/Strip: One-part, organic/inorganic intumescent strip with foil on one side. May be cut to fit irregular shapes. For use around non-metallic piping with or with RC-1 collar.
 - 1. Length: 24 inch (610 mm).
 - 2. Width: 1 or 2 inches.
 - 3. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - 4. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- U. 3M Fire Barrier Pass-Through Devices: One-Piece device for firestopping of cable penetrations through rated walls and floors.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- V. 3M Fire Barrier Tuck-In: Graphite-based, flexible, intumescent wrap strip for use around non-metallic piping. Adhesive closure tab.
 - 1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- W. 3M Fire Barrier Putty Sleeve Kit: Device used for firestopping of cable penetrations through fire rated walls and floors.
 - 1. Fire Resistance: For use in 1, 2 3 or 4 hour fire-rated systems.
 - 2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.
- C. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.
- D. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.
- E. Verify that environmental conditions are safe and suitable for installation of firestopping.
- F. If substrate preparation is the responsibility of another installer, notify Architect or Engineer of Record of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Prepare substrates in accordance with manufacturer's instructions and recommendations.

- B. Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.3 INSTALLATION

- A. Install in strict accordance with manufacturer's detailed installation instructions and procedures.
- B. Install so that openings are completely filled and material is securely adhered.
- C. Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.
- D. After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.
- E. Repair or replace defective installations in accordance with manufacturer's recommendations, listed systems details and applicable code requirements.
- F. At each through penetration, attach identification labels on both sides in location where label will be visible to anyone seeking to remove penetrating items or firestopping.
- G. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.
- H. Notify Authority Having Jurisdiction (AHJ) when firestopping installation is ready for inspection; obtain advance approval of anticipated inspection dates and phasing, if any, required to allow subsequent construction to proceed.
- I. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.

3.4 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing agency to inspect installed firestopping and to prepare reports indicating whether the installed work complies with the contract documents.
- B. Notify testing agency at least 7 days prior to date when firestopping installation will be ready for inspection; obtain advance approval of general schedule and phasing, if any, required to allow subsequent construction to proceed.

3.5 CLEANING AND PROTECTION

- A. Remove left over material and debris from Work area. Use necessary means to protect fire protection product(s) before, during, and after installation.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
- C. Install identification Labels for Through Penetration: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:
 - 1. The words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage."
 - 2. Listing agency's system number or designation.

3. System manufacturer's name, address, and phone number.
4. Installer's name, address, and phone number.
5. General contractor's name, address, and phone number (if applicable).
6. Date of installation.

END OF SECTION 230530

SECTION 230534 - GLYCOL HEAT TRANSFER FLUID AND FEED SYSTEM

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Pre-mixed propylene glycol solution for the closed loop heating water systems, and chilled water systems.
- B. Glycol Feed System

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data, system capacity adjustments, MSDS sheets, and requirements for installation.

1.3 QUALITY ASSURANCE

- A. Chemical shall meet all state and local pollution control regulations.
- B. Heat transfer solution shall be inhibited and specifically for use in commercial HVAC systems.
- C. System shall have a minimum 8-inch by 10-inch metal system nameplate denoting the following
 - 1. Date of original HTF charge.
 - 2. Description of heat transfer fluid.
 - 3. Manufacturer's name, address, and telephone.
 - 4. Percent ethylene glycol.
 - 5. Freeze point and burst point.
 - 6. Total system gallons.
 - 7. Reference to material safety sheet.
 - 8. Instruction for sampling of fluid.
 - 9. Month for annual sampling.
 - 10. Mailing instructions.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 PROPYLENE GLYCOL-BASED PRODUCT

A. MANUFACTURERS

1. Dow
2. Thermal Fluids Inc.
3. Dynalene
4. Coldflow HTP Covalent laboratories
5. Interstate Chemical

- B. Provide a 30% by volume (as installed) concentration of industrial grade inhibited propylene glycol heat transfer fluid as manufactured by the Dow Chemical Company (DOWFROST HD). The solution shall provide burst protection to -13°F. The propylene glycol solution as supplied by the manufacturer shall contain corrosion inhibitors specially formulated for cool storage services to keep internal surfaces free from corrosion and fouling and shall include buffers, reserve alkalinity agents, antifoaming additives, and a fluorescent dye to aid in leak detection. The solution shall be easily re-inhibited using specially formulated inhibitor readily available from the field manufacturer. The manufacturer shall provide at no cost propylene glycol yearly solution laboratory analysis. The analysis shall accurately report propylene glycol concentration, freeze point temperature, inhibitor level, alkalinity, particulate and recommended additions of glycol, inhibitor and buffers to ensure 20 Year minimum life. The fluid shall pass the ASTM D-1 384 test with less than 0.5 mils penetration per year.

- C. Automotive antifreeze or any solution containing silicates will not be acceptable.

- D. For systems volume of 1000 gallons or more, propylene glycol shall be supplied prediluted with water. For smaller systems propylene glycol concentrate shall be mixed with good quality water with less than 25 PPM of chloride and sulfate and less than 50 PPM of hard water ions (Ca⁺⁺, Mg⁺⁺). If good quality is unavailable supply pre-diluted solution.

2.2 GLYCOL FEED SYSTEM

A. MANUFACTURERS

1. Neptune Chemical Pump Company, Inc.
2. Advantage Control
3. IAT Construction Services, Inc.
4. John Wood Company

- B. General – Provide a completely, preassembled package Glycol Feed System as manufactured by Neptune Chemical Pump Company. Size and capacity as noted on drawings.
- C. Pump – Provide dual pump system with separate discharge and pressure switches to feed two independent systems from same tank. The pumps shall be a bronze rotary gear pump with a capacity of 1.5 gpm at a pressure of 100 psi. Pumps shall be mounted below the tank.
- D. Tank – The tank shall be constructed of polyethylene and be provided with a four-leg carbon steel stand with four bolt pads. The tank stand shall have upper and lower steel support banding to insure tank stability. Tank stand shall be painted with a two-coat system consisting of an oxide primer and alkyd enamel finish.
- E. Piping – Pump suction piping shall be piped using PVC fittings and tubing.
- F. A PVC ball valve and a cast iron “Y” strainer shall be provided in the pump suction piping.
- G. Pump discharge manifold shall be piped using Schedule 40 brass fittings suitable for chilled or hot water service. A pressure switch, ball valve, brass check valve and brass relief valve shall be mounted on the pump discharge assembly manifold. Piping shall be supported at both the top and bottom of the tank frame. The brass relief valve shall be piped back to the tank using PVC tubing and fittings. A pressure gauge shall be mounted in the discharge piping.
- H. Panel – A 115 Volt control panel with NEMA 4X enclosure consisting of the following shall be provided: H-O-A selector switch with running light and magnetic starter for feed pump. In AUTO, the pump is operated by the skid-mounted differential (adjustable) pressure switch and interlocked to a low- level float switch mounted in the side of the tank. Level switch also energizes a low- level audible alarm with silence push button for alarm acknowledgement. Panel shall also be equipped with an 8’ power cord with rounded plug. Panel shall be mounted to the tank frame and positioned at eye level for ease of operation. Panels mounted on tank lids or mounted below the tank are unacceptable. All electrical components (pressure switch, level switch, and pump) shall be wired in conduit to control panel. Loose, exposed, unprotected wire is unacceptable.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install fluid on suction side of system pump. Provide all piping and valving per manufacturers recommendations.

3.2 HYDRONIC SYSTEMS FLUSHING

- A. Hydronic systems shall be thoroughly flushed with approved pre-cleaning agent prior to being placed into service.

END OF SECTION 230534

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SECTION 230548 - MECHANICAL VIBRATION CONTROL

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Vibration isolators.
- B. Equipment bases.
- C. Flexible connectors.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting calculations, materials, sizes, and dimensions.

1.3 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Mason Industries.
- B. Korfund Company Inc.
- C. Consolidated Kinetics.
- D. Vibration Elimination Co.
- E. VMC Group- Amber/Booth
- F. Metraflex

2.2 VIBRATION ISOLATORS

- A. Open Spring Isolators:
 - 1. Spring Isolators:
 - a) For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b) Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Spring Mounts: Provide with levelling devices, minimum 0.25 Inch thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
- B. Restrained Spring Isolators:
1. Spring Isolators:
 - a) For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b) Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Spring Mounts: Provide with levelling devices, minimum 0.25 Inch thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 5. Restraint: Provide heavy mounting frame and limit stops.
- C. Spring Hanger:
1. Spring Isolators:
 - a) For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b) Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
 4. Misalignment: Capable of 20 degree hanger rod misalignment.
- D. Neoprene Pad Isolators:
1. Rubber or neoprene waffle pads.
 - a) 30 durometer.

- b) Minimum 1/2 inch thick.
 - c) Maximum loading 40 psi.
 - d) Height of ribs shall not exceed 0.7 times width.
- 2. Configuration: Single layer.
- E. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.
- F. Flexible piping connectors as follows:
 - 1. Molded reinforced neoprene construction with steel flanges and control rods.
 - 2. Flexible steel braided construction with steel flanges.
- G. Vibration insulation equipment bases
 - 1. Manufacturers subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co, Inc.
 - d. Vibration Isolation
 - e. Vibration Mounting and Controls, Inc.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and with manufacturer's engineered selections.
- B. Install isolation for motor driven equipment.
- C. Adjust equipment level when installed on concrete bases.
- D. Install spring hangers without binding.
- E. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

- F. Provide pairs of horizontal limit springs on fans with more than 6.0 Inch static pressure, and on hanger supported, horizontally mounted axial fans.
- G. Support piping connections to isolated equipment resiliently as follows:
 - 1. Up to 4 Inch Diameter: First three points of support.
 - 2. 5 to 8 Inch Diameter: First four points of support.
 - 3. Select three hangers closest to vibration source for minimum 1.0 Inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 Inch static deflection or 1/2 static deflection of isolated equipment.
- H. Connect wiring to isolated equipment with flexible hanging loop.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Mechanical identification methods, materials and devices.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting materials, sizes, and dimensions for identification systems.
- C. Submittals are required of valve schedules.

1.3 QUALITY ASSURANCE

- A. Identification requirements shall meet ASME A13.1.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 COMPONENTS

- A. Equipment Nameplates: Aluminum, permanently fastened to equipment, engraved or stamped.
- B. Stencils: Standard stencils shall be black enamel on a white background or white enamel on a dark background.
- C. Snap-on Plastic Pipe Markers: Preprinted, semi-rigid type, color-coded.
- D. Pressure-Sensitive Pipe Markers: Preprinted, color-coded, vinyl type with permanent adhesive.

PIPE	CODE	COLOR
Heating Hot Water Supply	HHWS	GREEN
Heating Hot Water Return	HHWR	GREEN
Chilled Water Supply	CHWS	GREEN
Chilled Water Return	CHWR	GREEN
Refrigeration Piping (Suction)	REF (S)	GREEN
Refrigeration Piping (Hot Gas)	REF (HG)	GREEN
Refrigeration Piping (Liquid)	REF (L)	GREEN
A/C Condensate	A/C COND	BROWN
Boiler Blow Down	BBD	BLACK

- E. Pipe Markers: Full band type.
- F. Plastic Duct Markers: Laminated plastic, color coded, and engraved with the service.
- G. Plastic Tape: Color-coded, pressure-sensitive, self-adhesive vinyl.
- H. Valve Tags: Polished tags with numbers and letters.
 - 1. HVAC Systems:
 - a. CHW – Chilled Water
 - b. HHW – Hot Water Heating
- I. Access Panel Markers: Engraved plastic laminate.
- J. Engraved Plastic-Laminate Signs: Sizes required to contain message.
- K. Plastic Equipment Markers: Standard color-coded, laminated plastic.
- L. Plasticize Tags: Preprinted, accident prevention.
- M. Valve Location Tags/labels for concealed equipment: All labels 1/2"x3" or larger plastic laminate with engraved 3/16" high and attached to the ceiling grid. The labels shall have the mark number and valve tag number. Standard colors and labeling are as follows:

<u>EQUIPMENT</u>	<u>COLOR</u>	<u>LABEL</u>
VAVs, Heat Pumps, etc.	Black/White letters	(VAV A – 01)
HVAC Cold Water Valves	Green/White letters	(CWS/CWR – 01)
HVAC Hot Water Valves	Green/White letters	(HWS/HWR – 01)
Fire/Smoke Dampers	Red/White letters	

2.2 VALVE CHARTS

- A. Valve charts shall be furnished by each respective Contractor and shall include the following items:
 - 1. Valve identification
 - 2. Location
 - 3. Purpose
- B. Valve charts shall be included in the Maintenance and Operating Manuals.

PART 3-EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Piping, equipment and valve identification shall be completed prior to issuance of substantial completion.
- B. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.
- C. Equipment: Identify air handling units, fan powered VAV boxes, and VAV boxes, VFD's, damper locations, duct smoke detectors, chillers, duct reheat coils, water heaters, pumps, and fans with plastic nameplates. Pumps must be identified with metal tags.
- D. Controls: Identify control panels and major control components outside panels with plastic nameplates.
- E. Install plastic pipe markers in accordance with manufacturer's instructions.
- F. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- H. Identify all disconnects and starters related to HVAC, Plumbing and Fire Protection equipment.
- I. Identify piping, concealed or exposed with plastic tape pipe markers. Use tags on piping 3/4 Inch diameter and smaller. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Identify pressure of high temperature hot water in addition to service, flow direction and temperature.
- J. Provide ceiling tacks to locate items specified above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- K. On ducts with flexible wrap insulation, mark manual volume damper quadrant locations with fluorescent spray paint on insulation.
- L. On ductwork to receive tagging, mark locations of items mounted in ducts on insulation.

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. The testing, adjusting, and balancing of the HVAC air and water systems.
- B. The performing contractor's certification requirements.

1.2 SUBMITTALS

- A. Submittals are required and shall include the complete certified report for all air and water system pressure testing and balancing including all electrical performance of each piece of HVAC equipment.
- B. Prior to commencement of the work described in this Section, the testing, adjusting, and balancing contractor shall submit verification of his AABC or NEBB certification to the Design Professional for acceptance.

1.3 QUALITY ASSURANCE

- A. The testing, adjusting, and balancing contractor shall be either AABC or NEBB certified for the work described herein.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCT

2.1 COMPONENTS

- A. The Contractor shall provide his own properly calibrated equipment to pressure test, air balance, water balance and to measure electrical characteristics of each piece of HVAC equipment.

PART 3-EXECUTION

3.1 REQUIREMENTS

- A. Testing, adjusting, and balancing plan.
- B. Systems readiness checks.
- C. Testing, Adjusting, and Balancing Procedures: AABC's National Standards or NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- D. Equipment settings marked to show final settings.

- E. Balancing shall be performed to meet the requirements of ASHRAE standard 90.1
- F. The owner has a right to request up to 25% of all the balanced systems to be verified during the warranty period of the project.

3.2 HVAC SYSTEMS AIRFLOW AND WATER FLOW RATE TOLERANCES

- A. Supply, Return, and Exhaust Fans: Minus 5 percent to plus 10 percent.
- B. Air Outlets and Inlets: 0 to minus 10 percent.
- C. Heating Water Flow Rate: 0 to minus 10 percent.
- D. Cooling Water Flow Rate: 0 to minus 5 percent.

3.3 REPORTING

- A. Initial Construction Phase Report: Based on examination of Contract Documents, on adequacy of design for systems balancing devices.
- B. Status Reports: As Work progresses.
- C. Final Report: Certification sheet, with content and format according to AABC or NEBB standard forms.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Qualitative requirements for interior and exterior pipe and pipe specialty/equipment insulation, jacketing and accessories.
- B. Qualitative requirements for interior duct, plenum, and equipment insulation, jackets, and accessories.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Submittals are required and shall include product data noting materials, thickness for each service, aged thermal qualities, and accessories.

1.3 QUALITY ASSURANCE

- A. Fire performance characteristics in accordance with ASTM E 84 for flame spread of 25 and smoke developed of 50.
- B. Materials and installation in accordance with NFPA 255 and UL 723.
- C. Installed R-value shall meet the requirements of ASHRAE Standard 90.1, this specification, and they shall be provided to eliminate condensation, whichever requires a greater R-value.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pipe and Pipe Specialty/Equipment Insulation
 - 1. Armacell
 - 2. Rubatex
 - 3. Owens Corning
 - 4. Johns Manville (Manville)
 - 5. Knauf
- B. Duct and Equipment Insulation

1. Owens Corning
2. Johns Manville (Manville)
3. Knauf
4. Certain-Teed Corporation

2.2 MATERIALS

A. Glass Fiber: With ASJ jacket (unless noted otherwise) and with vapor-barrier.

1. Preformed Pipe Insulation: ASTM C 547, Class I, rigid, minimum density to be 3.5 pcf, Owens Corning SSL II with ASJ Max jacket (or equal).
2. Board Insulation: ASTM C 612, Type 2, rigid and semi-rigid. Minimum density to be 6 pcf. Owens Corning 705 or equal.
3. Blanket: ASTM C 553, Type II, Class F-1, with FSK vapor barrier jacket, minimum density to be 1 pcf, Owens Corning Type 100 SOFTR Duct Wrap FRK or equal.
4. Adhesive: UL Classification; Nonflammable, and as recommended by insulation manufacturers.
5. Pre-formed Pipe and Tank Insulation: ASTM C1393, Owens Corning Fiberglas Pipe and Tank with ASJ Max jacket
6. Maximum "K" Value: 0.27 at 75 degrees F.

B. Flexible Elastomeric Cellular: Flexible cellular elastomeric material, molded or sheet.

1. Preformed: ASTM C534, Type II.
2. Adhesive: Waterproof vapor retarder, as recommended by insulation manufacturer.
3. Maximum "K" Value: 0.245 at 75 degrees F.
4. Armacell or Rubatex.

C. Duct Liner Insulation

1. Material: Liner Board, ASTM C518.
2. Coating: ASTM C1071 (Microbial growth resistant).
3. Adhesive: UL listed waterproof, as recommended by insulation manufacturer.
4. Fasteners: Galvanized steel pins, welded or mechanically fastened.
5. Maximum "K" Value: 0.23 at 75 degrees F.

- 6. Owens Corning QUIETR Duct Liner or equal.
- D. Insulating Cements
 - 1. Mineral fiber, hydraulic-setting insulating and finishing cement.
 - 2. Expanded or exfoliated vermiculite.
 - 3. Must be compatible with insulation/jacket.
- E. Adhesives: MIL-A-3316C, Classes 1 and 2, Grade A, and must be compatible with insulation/jacketing.
- F. Field applied jackets shall be as follows:
 - 1. Jacketing for Insulated Outdoor Ductwork: Self-adhesive, 3M Venture Clad 1579GCW Insulation Jacketing, or equal, zero permeability, vapor barrier, minimum 140 lb/inch tensile strength, aluminum color.
- G. N/A
- H. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- I. 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.
- J. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- K. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Leak test piping, equipment and ductwork system before installing insulation systems.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's recommendations and in conformance with the in-force building and mechanical codes and industry standards.
- B. Where a vapor barrier is called for, it shall be continuous.
- C. Provide proper support, insulation, and finishing at hanger systems.
- D. Ductwork shall be externally insulated for all applications except for specific sound attenuation means as called for on drawings or as specified within documents.
- F. Insulated cold pipes and equipment conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied where possible, field applied otherwise.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
 3. Finish fitting insulation with preformed PVC fitting covers and vapor barrier adhesive.
 4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- G. For insulated pipes conveying fluids above ambient temperature:
1. Provide standard jackets, with vapor barrier factory applied.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
 3. Finish fitting insulation with preformed PVC fitting covers and adhesive.
 4. For hot piping and equipment conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with factory applied vapor barrier jackets.
 2. Finish with compatible and matching tape and vapor barrier jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- I. Insulated ductwork conveying air above ambient temperature:
1. Provide factory applied jacket, with or without vapor barrier, and finish with matching compatible tape.
 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- J. Finish insulation at supports, protrusions, and interruptions.
- K. All duct insulation shall be applied so that there is no fiberglass exposed to any air streams without filters downstream. All fiberglass insulation, including all exposed edges, shall be coated with a suitable, ASHRAE 62.1 rated, material provided between fiberglass and the air stream.

- M. Following items are not insulated:
- a. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
 - b. Vibration control devices.
 - c. Testing laboratory labels and stamps.
 - d. Nameplates and data plates.
 - e. Factory insulated access panels and doors in air distribution systems.
 - f. Factory insulated equipment such as boilers.

3.2 INSULATION AND FINISH JACKETING REQUIREMENTS

- A. Drip pan piping and auxiliary drip pans, cold refrigerant piping, cold condensate piping, and auxiliary drain piping: $\frac{1}{2}$ " thick flexible elastomeric cellular pipe insulation. Seal all joints and seams with Armacell #520 (or equal compatible product) adhesive. Insulate valves and fittings to match adjacent pipe insulation. If flexible elastomeric insulation used outdoors, it shall be finished with two coats of insulation manufacturer's weather-proofing coating. Vapor barrier to be created.
- B. Other exposed ducts in air-conditioned spaces: No insulation required unless noted on drawings.
- C. All concealed round and rectangular supply air or return air ducts, all supply air ductwork located in return air ceiling plenums, reheat coils, and all exhaust and relief air ducts within 10' of the exterior, all outside air intakes from outside to unit mixing boxes, filter boxes, or preheat coils, and ducted combustion air intakes: Insulate with 1.5" thick fiberglass wrap with flame retardant FSK facing. Wrap insulation tightly on the duct with all joints butted. Adhere insulation with 4" strips of bonding adhesive at 8" o.c. Tape all joints and seams with 4" wide tape and vapor barrier adhesive. Vapor barrier to be created.
- D. Ducts lined for sound: Insulate with 1" thick fiberglass duct liner. Install with metal nosing on exposed upstream edges of supply duct.
- E. HW heating piping: ASJ jacketed fiberglass pipe insulation, 1.5" thick for up thru 1.25" pipe sizes, 2" thickness for larger sizes.
- F. CHW piping indoors: ASJ jacketed fiberglass pipe insulation, minimum 1" thickness. Vapor barrier to be created.
- G. CHW piping outdoors: Jacketed per Section O fiberglass pipe insulation, minimum 2" thickness. Vapor barrier to be created.
- H. Refrigerant Hot Gas Piping Indoors: ASJ jacketed fiberglass pipe insulation, 1" thick.
- I. Cold mechanical equipment: ASJ jacketed fiberglass insulation, same thickness as adjoining pipe. Vapor barrier to be created.
- J. Hot mechanical equipment: ASJ jacketed fiberglass insulation, same thickness as adjoining

pipe.

- K. Hot condensate or dump water (such as from steam humidifiers and condensing boilers): Insulate same as for HW heating piping above.
- L. HVAC and plumbing gas appliance flues (if flues not factory insulated): Minimum 1" thick ASJ jacketed fiberglass pipe or pipe and tank insulation.
- O. Provide Field Applied Insulation Protective Jacketing as follows (to be provided in addition to requirements listed above):
 - 1. Exposed piping in mechanical rooms, stairwells, entryways, vestibules, and as otherwise subject to abuse, jacket with PVC on straight lengths and with PVC fitting covers on fittings. Seal all joints and seams.
 - 2. Outdoor insulated hydronic and glycol piping, and other components such as CRAC dry cooler expansion tanks, jacket with self -adhesive 3M Ventureclad or equal.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF MECHANICAL SYSTEMS

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 refers contracts to commissioning process requirements for mechanical systems, assemblies, and equipment found in related division 01 sections.
- B. Related Sections:
 - 1. Division 01 Section 01 91 13 "Commissioning Requirements" for definitions, roles and responsibilities, and process requirements for all systems to be commissioned.

1.3 DESCRIPTION

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify and document proper performance of equipment and systems.
 - 3. Verify that the Owner's operating personnel are adequately trained.
- B. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION 230800

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Sub-Contractor.
- B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.
- C. The work of this Division shall be as required by the Specifications, Drawings, Point Schedules and Division 230993.
- D. If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.2 BMS DESCRIPTION

- A. Massillon Local School District building control requirements are as follows:
 - 1. The current conditions within the district with respect to HVAC Controls: An existing enterprise head end system is in operation, and it handles access to the existing control systems/units. Many of the existing controls are older Trane DDC controls. The existing districts controllers within the buildings are tied to the head end through the Niagara enterprise system. Gardiner Automation is engaged in working in the district in the Washington High School building and the district's enterprise front end. The Stark/Portage Area Computer Consortium (SPARCC) has been retained and will be used as district oversight.
 - 2. Any software or components installed must NOT require administrator level or higher access to run. Administrator rights for installation are acceptable.
 - 3. Any software must NOT require JAVA to install or operate.
 - 4. Any software must run on the existing Niagara Supervisor Server and must be compatible with all future upgrades released by Microsoft within three (3) months of the release.
 - 5. Any software must NOT require FLASH to install or operate.

- B. General: The control system shall consist of a peer-to-peer network of digital building control panels and Network Area Controller(s) (NAC) within each facility. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard web browsers, via the Internet and/or local area network. Each NAC shall be capable of communication with the OPEN BACNet controllers. The web browser shall provide users with an interface with the system through dynamic color graphics of building areas and systems.
- C. The Facility Management and Control System (FMCS) shall be based on the Niagara 4 Framework™ (or “Gardiner KMC brand), a framework technology developed by Tridium, and systems not developed based upon the Niagara 4 Framework™ technology are not acceptable.
- D. All control devices furnished within this section shall be programmed directly through the Niagara 4 workbench embedded toolset upon completion of the project.
- E. Approved manufacturers listed shall be required to provide programming and configuration tools for the BACNet controllers for the project. The use of proprietary configurable and programmable controllers that require additional software tools for post installation maintenance and programming shall not be acceptable.
- F. The Building Management System (BMS) shall be based for use with the enterprise IT systems. This functionality shall extend into the equipment rooms and be capable of providing an integrated solution enhancing the efficiency and life cycle cost through advanced analytics, technical support and service support. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. The contractor shall be responsible for coordination with the owner’s IT staff to ensure that the BMS will perform in the owner’s environment without disruption to any of the other activities taking place on that LAN. This shall consist of control systems for:
- G. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- H. Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be using a standard database platform: Microsoft Data Engine (MSDE).

- I. The work of the single BMS Sub-Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings, Division 230993 and the associated interfacing work as referenced in the related documents.
- J. The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
- K. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- L. Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- M. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
 - 1. Operator information, alarm management and control functions.
 - 2. Enterprise-level information and control access.
 - 3. Information management includes monitoring, transmission, archiving, retrieval, and reporting functions.
 - 4. Diagnostic monitoring and reporting of BMS functions.
 - 5. Offsite monitoring and management access.
 - 6. Energy management
 - 7. Standard applications for terminal HVAC systems.
 - 8. REMOVED

9. Indoor Air Quality monitoring and control

1.3 QUALITY ASSURANCE

A. General

1. The Building Management System Sub-Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.
2. The term “manufacturer” when used to identify an automatic temperature control sub-contractor/supplier, shall mean the complete system of building energy management. Components of the completed system shall include but not being limited to, hardware equipment, engineering, wiring, installation, sequence of operations, network architecture, commissioning, training, software programming and warranty.
3. The BMS Sub-Contractor shall be a recognized national manufacturer, installer and service provider of BMS.
4. HVAC Contractors installing their own controls will not be accepted. **NO EXCEPTIONS.**
5. The BMS Sub-Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
6. As evidence and assurance of the contractor’s ability to support the Owner's system with service and parts, the contractor must have been in the BMS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.
7. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems and shall be the manufacturer’s latest standard of design at the time of bid.

B. Workplace Safety and Hazardous Materials

1. Provide a safety program in compliance with the Contract Documents.

2. The BMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
3. The Contractor and its employees and sub trades comply with federal, state and local safety regulations.
4. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA having jurisdiction for at least each topic listed in the Safety Certification Manual.
5. Hazards created by the Contractor, or its subcontractors, shall be eliminated before any further work proceeds.
6. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
7. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.
8. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the Authority Having Jurisdiction (AHJ) at the Project site.
9. The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

C. Quality Management Program

1. Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:
 - a. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
 - b. Manage the financial aspects of the BMS Contract.

- c. Coordinate as necessary with other trades.
- d. Be responsible for the work and actions of the BMS workforce on site.

1.4 REFERENCES

A. All work shall conform to the following Codes and Standards, as applicable:

- 1. National Fire Protection Association (NFPA) Standards.
- 2. National Electric Code (NEC) and applicable local Electric Code.
- 3. Underwriters Laboratories (UL) listing and labels.
- 4. UL 864 UUKL Smoke Control
- 5. UL 268 Smoke Detectors.
- 6. UL 916 Energy Management
- 7. NFPA 70 - National Electrical Code.
- 8. NFPA 90A - Standard for The Installation of Air Conditioning And Ventilating Systems.
- 9. American National Standards Institute (ANSI).
- 10. National Electric Manufacturer's Association (NEMA).
- 11. American Society of Mechanical Engineers (ASME).
- 12. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and ASHRAE 62 IAQ as applicable.
- 13. Air Movement and Control Association (AMCA).
- 14. Institute of Electrical and Electronic Engineers (IEEE).
- 15. American Standard Code for Information Interchange (ASCII).
- 16. Electronics Industries Association (EIA).
- 17. Occupational Safety and Health Administration (OSHA).

18. American Society for Testing and Materials (ASTM).
 19. Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.
 20. Americans Disability Act (ADA)
 21. ANSI/ASHRAE 135-2016, BACnet® -A Data Communication Protocol for Building Automation and Control Networks.
- B. In the case of conflicts or discrepancies, more stringent regulation shall apply.
- C. All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.5 SUBMITTALS

- A. Shop Drawings, Product Data, and Samples
1. The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
 2. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
 3. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.
 4. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
 5. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
 6. The BMS Contractor shall correct any errors or omissions noted in the first review.
 7. At a minimum, submit the following:

- a. BMS network architecture diagrams including all nodes and interconnections.
- b. Systems schematics, sequences and flow diagrams.
- c. Points schedule for each point in the BMS, including Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
- d. Samples of Graphic Display screen types and associated menus.
- e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
- f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
- g. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
- h. Room Schedule includes a separate line for each VAV box and/or terminal unit indicating location and address and room thermostat specifics.
- i. Details of all BMS interfaces and connections to the work of other trades.
- j. Listing of all read and or write points derived via interfaces to mechanical system components as required per project specifications, sequences of operation, points list(s), and/or required for correct systemsoperation and functionality. Points shall be identified as to point type (AI, BI, AO, DO, AV, DV), point source (read, write, commandable), interface type (BACnet, N2, etc.) point ID in BMS and point ID in mechanical system, mechanical system source (VFD, RTU, Chiller, etc.), point (object) name (% speed, fan status, cws temp, etc.) and point description (speed of motor, fan on, chilled water

supply temperature, etc.)

- k. Product data sheet section with an index identifying each product utilized in the installed BMS system and product data sheet(s) for each product. The index shall individually list each product with the associated numerically sequenced page number(s) of the product data sheets. For all products including software, provide product data sheet(s) or marked catalog pages that include part number, photo, complete specifications and numerically sequenced page number(s) referenced in the index.

1.6 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 Compact Disc media, 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. Manufacturer's 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 in other trades.
- 2. The Operation and Maintenance Manual CD 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.

1.7 WARRANTY

A. Standard Material and Labor Warranty:

1. Provide a two-year labor and material warranty on the BMS.
2. If within twenty-four (24) months from the date of final payment, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such as replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

1.8 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed hardware and software shall become the property of the Owner. These items include but are not limited to:

1. Project graphic images
2. Record drawings
3. Project database
4. Project-specific application programming code
5. All documentation
6. All programming tools shall be provided to the owner on a laptop computer or embedded within the Niagara system control system.

1.9 BAS/BMS OPEN SYSTEM DESIGN AND QUALIFICATIONS

A. Open System Design: It is the owners expressed goal to implement an open Building Automation System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system. The BAS manufacturer /contractor must provide proof of open system design as outlined below.

B. Prior to award of the contract, the BAS contractor is to provide proof of "Open System Design" with the following requirements:

1. Provide proof of having a local office within 50 miles of project for at least 5 years, staffed by trained personnel capable of providing

installation, engineering, programming, servicing, commissioning, instruction, routine maintenance, and emergency service on systems.

2. The control system shall utilize the Niagara4 software framework.

The Contractor shall have a minimum of 5 years experience in the sales, installation, engineering, programming servicing and commissioning of Niagara4.

Submit the Niagara Compatibility Statement (NiCS) via a letter from the manufacturer. The NiCS shall have no connectivity restrictions and all aspects of the Niagara Framework will be provided to maintain an Open System Design. The System as provided shall confirm with the following NiCS properties (Station Compatibility In, Station Compatibility Out, Tool Compatibility In, AND Tool Compatibility Out shall each have a value of "All").

- C. The controls system shall conform to the following guidelines for communication protocols.

1. BACnet shall be used for all BAS provided controllers.
The manufacturer of the hardware and software components, as well as its subsidiaries, must be a member in good standing of the BACnet International and all controllers used shall be BACnet Listed with documentation on the BACnet website.
(<https://www.bacnetinternational.net/btl/search.php>)
2. The use of BACnet Communications protocol alone shall NOT warrant an "Open System Design." Manufacturers must adhere to all aspects of "BAS Open System Design and Qualifications" and "Acceptable System Manufacturers" sections to comply.
3. Modbus shall only be acceptable for third party devices.
4. Proprietary communications protocols shall NOT be acceptable.

- D. A software programming tool shall be provided for this project and adhere to the following guidelines:

1. All software tools needed for full functional use, including programming of controllers, Niagara4 Framework network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the owner or his designated agent.

2. The software programming tool shall be free of charge and openly available for download from the internet.
3. For any manufacturer that does not have a free programming tool the manufacturer must provide the tool with this project for a minimum of 5 years with proof of availability via letter from the manufacturer.
4. Any licensing required by the manufacturer now and to the completion of the warranty period, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

- A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
 1. The Building Management System shall consist of the following:
 - a. Standalone Network Automation Engine(s)
 - b. Field Equipment Controller(s)
 - c. Input/Output Module(s)
 - d. Local Display Device(s)
 - e. Distributed User Interface(s)
 - f. Network processing, data storage and communications equipment
 - g. REMOVED
 - h. Other components required for a complete and working BMS

- B. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- D. Acceptable Manufacturers
 - 1. Distech Controls (Basis of Design)
 - 2. KMC Controls
 - 3. Niagara Edge Controllers
- E. All other manufacturers/contactors besides the "Basis of Design" manufacturer. (Including those listed above) must submit a compliance matrix outlining "C-Comply", "D - Does Not Comply", and "E - Exclude" for the entirety of the 230900 and 230993 sections prior to bid award.
 - 1. Being listed as an approved manufacturer/contractor does not preclude the bidder from meeting all aspects and requirements of this specification.
 - 2. Those bidders not prequalified prior to review of bids will not be considered responsive. To be prequalified a bidder must be accepted to bid on the project by the Engineer either by a bid addendum or documented RFI response from the Engineer. No other prequalification shall be acceptable.
- G. Quality Assurance
 - 1. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001 :201508 manufacturer, for a minimum duration of 5 years, at time of bid.
- H. Computer Hardware
 - 1. Head End Workstation/Server Requirements
 - a. The existing head end workstation/server may be re-used if compatible with the proposed new control work, but it will need to be updated/expanded as required. If new equipment is required, the server

and workstation shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 16 GB RAM, and a 1TB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), VM support, and an ethernet adapter (101100MB with RJ45 connector). Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.

- b. The server shall support all network/building controllers, OWSs, and 3rd party mechanical / electrical systems connected to the Facility Management Control / Building Automation System Local Area Network.
- c. Acceptable Manufacturers are:
 - i. Dell
 - ii. Lenovo
 - iii. HP (Hewlett Packard)

I. Workstation Hardware Requirements (If new is required)

- 1. The Workstation shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 8 GB RAM, and a 500GB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), Microsoft Office programs, VM support, an ethernet adapter (101100MB with RJ45 connector), 32X CD-ROM drive, and 2-USB ports.
- 2. A minimum 21", HDMI, DVI-D video interfaces, minimum 1024 x 768 resolution, 4x3 widescreen, LED color monitor with a minimum 60 Hz refresh rate shall also be included.
- 3. A mouse and keyboard shall be provided.
- 4. Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.
- 5. Workstation(s) should be loaded with Programming Tools
- 6. Acceptable Manufacturers are:

- a. Dell
 - b. Lenovo
 - c. HP (Hewlett Packard)
7. Uninterruptable Power Supplies (Provide new)
- a. Provide the OWS, Server, and each network/building controller with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short-term power interruptions of up to 15 minutes duration.
 - b. Acceptable Manufacturer is APC.
- J. Remote Access and Cyber Security Best Practices
1. Remote Access
- a. The BAS contractor shall comply with the owner's IT infrastructure security policies for remote access. The owner's IT team shall provide VPN, firewalls, etc. as needed for secure remote access.
 - b. A VPN and firewall must be used for secure remote access.
2. Cyber Security Best Practices
- a. The BAS network shall be separate from the owner's IT infrastructure besides a single point connection for remote access (owner provided internet access). All ethernet switches and communication backbone required for a fully operational BAS shall be provided by the BAS contractor.
 - b. Refer to the "Communication Backbone" section of this specification for further details on segmenting the network (VLANs, subnets) and when managed switches (with port security, network user interface, etc.) are required based on building size / type.
 - c. Do not use factory provided usernames and passwords. Update passwords and usernames regularly for strong system security.
 - d. Update software and firmware regularly.

- e. Adhere to controls manufacturer hardening guidelines where applicable.

K. Operator Software

1. Real-Time Displays

- a. Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.
- b. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.

2. On-Line Help

- a. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.

3. Security

- a. Each operator shall be required to log on to that system with a username and password in order to view, edit, add, or delete data.
- b. System security shall be selectable for each operator.
- c. The system administrator shall have the ability to set passwords and security levels for all other operators.
- d. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
- e. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
- f. This auto log-off time shall be set per operator password.
- g. All system security data shall be stored in an encrypted format.

4. System Diagnostics.

- a. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building

management panels, and controllers.

- b. The failure of any device shall be annunciated to the operator.

5. Third-Party Windows-Based Programs

- a. The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.
- b. Graphics generation shall be done using standard Windows packages.
- c. No proprietary graphics generation software shall be needed.

6. Override

- a. It shall be possible for the operator to override automatic analog and digital output commands.
- b. Where the BAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic BAS control of any output and to originate a manual analog or digital output command.
- c. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.

7. Password Protection

- a. Provide a security system that prevents unauthorized use unless the operator is logged on.

8. Trend Data

- a. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk.
 - i. Archived files shall be appended with new sample data, allowing samples to be accumulated over 3 years.

- ii. Systems that write over archived data shall not be allowed, unless limited file size is specified.
- iii. Samples may be viewed at the operator's terminal in a trend log.
- iv. Logged data shall be stored in spreadsheet format.
- v. Operator shall be able to scroll through all trend log data.
- b. Software shall be included that can graph the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colors and these graphs shall show object type value relative to time.
- c. Operator shall be able to change trend log setup information such as time intervals and objects logged

9. Graphics

- a. The operator's workstation shall display all data associated with the project.
 - i. Operator's workstation shall display all data using 3-D graphic representations of all mechanical equipment.
- b. System shall be capable of displaying graphic file, text, and dynamic object data together on each display.
 - i. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.
 - ii. All information on any display shall be dynamically updated without any action by the user.
 - iii. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.
 - iv. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.
 - v. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area would change

based on the analog objects value.

- vi. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint.
- c. Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.
- d. All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)
- e. Entire system shall operate without dependency on the operator's terminal.
- f. Provide graphic generation software at each workstation.

10. Alarms

- a. Operator's terminal shall provide audible, visual, electronic and printed means of alarm indication.
- b. Any alarm may be handled based on its individual or assigned class actions.
- c. Displayed on the Alarm console.
 - i. The system shall be provided with a dedicated alarm window or console.
 - ii. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm.
- d. Alarm reports shall be viewable via the BAS system and available for delivery by electronic mail (e-mail) or printing.
- e. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal.
 - i. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.

11. Scheduling

- a. Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.
- b. Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.
- c. At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

12. Archiving

- a. Store back-up copies of all controller databases in at least one OWS and the server.
- b. Provide continuous supervision of the integrity of all controller databases.
- c. Data base back up and downloading to occur over LAN without operator intervention.
- d. Operator to be able to manually download entire controller database or parts thereof.

13. Reports

- a. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.
- b. Provide software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.
- c. As a minimum, the following reports shall be configured on the system:
 - i. Dynamic Reports ☐ to allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency.

- ii. Summary Report: To permit the display or printing of the dynamic values for the user specified points.
- iii. Trend Reports: To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.
- iv. Historical Data Collection: Provision shall be made to ensure historical data is not lost.
- v. Alarm Summary: Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
- vi. Disable Point Summary: Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.
- vii. Run Time Summary: Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.
- viii. Schedule Summary: Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.
- ix. User Record Summary: Provide a summary of all user records to include as a minimum; username, password, initials, command access level and point groups assigned.

K. BAS Controllers

- 1. All controllers on the job shall have the following minimum requirements:
 - a. IP Communication (BACnet/IP)
 - i. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VA Vs, FCUs, etc.)

- ii. Support for IPv4 addressing
 - iii. DHCP support and Auto DNS
 - iv. Baud rate of not less than 100 Mbps
 - v. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
1. Supporting controller daisy chaining on the Ethernet network via integral switch functionality.
 2. Integrated fail-safe should allow for communication when the controller is powered down.
 - vii. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (such as JACE, Supervisor, Etc.) and shall be capable of assuming all responsibilities typically assumed by a Network Control Unit.
 - b. Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected to the same communication cabling. Slave controllers are not acceptable.
 - c. The resulting network will be a 'Flat' topology with all devices (controllers, workstations, ...) connecting at the same physical network level
2. Memory and Processing
 - a. 512KB of RAM and 4GB of non-volatile flash memory.
 - b. 32-bit microprocessor operating at a minimum of 600 MHz
 3. Each individual controller shall have an embedded web based HTML5 visual interface with the following functionality without reliance on any other controller for access:
 - a. Typical and custom control processes
 - b. Scheduling
 - c. Energy management applications

- d. Alarm management applications
 - e. Historical/trend data for points specified
 - f. Maintenance support applications
 - g. Graphical interface
4. Shall be capable of monitoring/controlling the following types of inputs/outputs:
- a. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - b. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - c. Digital outputs including Form C relay outputs and Triac outputs
 - d. Analog outputs of 4-20 mA and 0-10 Vdc.
 - e. A minimum of 10% spare capacity for each point type for future point connection.
 - f. Any software required for programming shall be unlicensed and openly available
 - g. Auto commissioning features shall be available for VA Vs and FCUs to schedule automatic testing and record values (air flows, pressures, temperatures, etc.) for different operating modes. The auto commissioning feature shall be able to email reports and run commissioning on a specified schedule.
 - h. Power and Environmental Requirements:
 - i. 24 V AC with local transformer power
 - ii. The controllers shall also function normally under ambient conditions of -40 °F to 158 °F and 0% to 90% RH (non-condensing).
 - iii. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
 - i. Code Compliance:

- i. "FIPS 140-2 Level 1 Compliant" cryptographic module
- ii. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
- iii. UL916 Energy management equipment
- iv. FCC rules part 15, subpart B, class B
- v. UL94-V0 flammability rating

2.2 INPUT DEVICES

A. General Requirements

- 1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

- 1. General Requirements:
 - a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
 - b. The temperature sensor shall be of the resistance type and shall be either two-wire 1000-ohm nickel RTD, or two-wire 1000-ohm platinum RTD.
 - c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Room Temp	$\pm 1.0^{\circ}\text{F.}$
Duct Temperature	$\pm 1.0^{\circ}\text{F.}$
All Others	$\pm 1.0^{\circ}\text{F.}$

2. Room Temperature Sensors

- a. For use in spaces such as classrooms
- b. Room sensors shall be constructed for either surface or wall box mounting.
- c. Room sensors shall have the following options when specified:
 - i. Setpoint reset slide switch providing a ± 3 -degree (adjustable) range.
 - ii. Individual heating/cooling setpoint slide switches.
 - iii. A momentary override request push button for activation of after-hours operation.

3. Room Temperature Sensors with Integral Display

- a. For use in non-classroom spaces such as administrative rooms and offices.
- b. Room sensors shall be constructed for either surface or wall box mounting.
- c. Room sensors shall have an integral LCD display and four button keypad with following capabilities:
 - i. Display room and outside air temperatures.
 - ii. Display and adjust room comfort setpoint.
 - iii. Display and adjust fan operation status.
 - iv. Timed override request push button with LED status for activation of after-hours operation.
 - v. Display controller mode.
 - vi. Password selectable adjustment of setpoint and override modes.

4. Blank Control Sensor

- a. For use in common space transient areas such as corridors

- b. No manual temperature adjustment shall be available. All adjustability shall be from the BAS system.
- c. Shall be mounted at a height above the locker height and temperature offset to represent the temperature reading at normal mounting height.

5. Outside Air Sensors

- a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
- b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
- c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

6. Duct Mount Sensors

- a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned to be easily accessible for repair or replacement.
- b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

7. Averaging Sensors

- a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
- b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot-long segment.

- c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

8. Humidity Sensors

- a. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
- b. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
- c. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 5% and 95% RH @ 77 Deg F unless specified elsewhere.
- d. Outside air relative humidity sensors shall be installed with a rainproof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with steatite fittings and stainless-steel bushings.
- e. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- f. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- g. Acceptable Manufacturers: Veris Industries, Mamac or engineer approved equal.

9. Duct Shielded Static Pressure Probe

- a. Probes shall be complete with mounting brackets, noise suppression chamber and brass compression connector.

10. Differential Pressure Transmitters

- a. Air type: Transmitter shall be provided in a NEMA enclosure with barbed fittings for connection of signal lines. Wiring terminations shall be short circuit and reverse polarity protected. Accuracy shall be +/- 1 % full scale with an over pressure rating of 10 psi. Transmitter shall be temperature compensated from 25 to 150 deg.

- F. with an operating range of 0 to 175 deg. F. Output shall be 4 to 20 ma.
- b. Wet type: Shall be enclosed in a NEMA enclosure with a 5-valve bypass assembly. The transmission shall have an over pressure rating of at least 200 psi on either port without permanent damage. Transmitters shall have externally accessible zero and span adjustments. The transmission shall have a static error band of +/- .5% full scale including linearity, hysteresis and repeatability. Output of transmitter shall be 4 to 20 ma.
 - c. Industrial Grade: Shall use silicon strain gauge technology and a two-wire d/p Cell transmitter to measure the difference between two pressures and transmit a proportional (or square root) 4-20 mA output signal. Differential pressure transmitters shall be used in conjunction with Venturi Flow Stations and shall be as manufactured by Foxboro, Rosemount or approved equal with the following specification requirements:
 - d. Zero Suppression: To upper range limit minus the span
Ambient Temperature Effect: Total effect for a 100 DEGF change within Normal Operating Conditions limits is + or - (0.2% of URL +0.1% of span) Accuracy (Includes linearity, Hysteresis, and Repeatability): + or - 0.20% of calib. span for spans less than 6.7% of URL Over range Limit (DP) and Maximum Static Pressure: 25 Mpa, 3625 psi, 250 bar or kg/ (cm*cm). Either side may have higher pressure during over range.
11. Flow Monitoring – Supply, Return Fan and Toilet Exhaust
- a. Air Flow Monitoring
 - i. Fan Inlet Air Flow Measuring Stations
 - 1. At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.
 - 2. Each traverse probe shall be of a dual manifolded, cylindrical, type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward

projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm 20^\circ$ in the approaching air stream.

3. The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.
4. Airflow measuring stations shall be manufactured by Air Monitor Corp., Tek-Air Systems, Inc., or Ebtron. KMC Outside Air Flow Measuring System shall also be acceptable.

b. Single Probe Air Flow Measuring Sensor

The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.

c. Duct Air Flow Measuring Stations

- i. Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
- ii. Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4"

maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

- iii. The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.
- iv. The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.
- v. The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.
- vi. Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.

d. Installation Considerations

- i. The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065" w.c. at 1000 feet per minute, or .23" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.
- ii. The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.
- iii. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inches to three inches to facilitate matching connecting ductwork.

- iv. Where control dampers are shown as part of the airflow measuring station, opposed blade precision-controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.
 - v. The stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.
 - vi. Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard. KMC Outside Air Flow Measuring System shall also be acceptable.
- e. Static Pressure Traverse Probe
 - i. Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe.
 - ii. Acceptable manufacturers: Cleveland Controls
- f. Shielded Static Air Probe
 - i. A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.
- g. Water Flow Monitoring
 - i. Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
 - ii. Acceptable manufacturers: Onicon.

12. Smoke Detectors

- a. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

13. Status and Safety Switches

a. General Requirements

- i. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlocked wired to shut down respective equipment.

b. Current Sensing Switches

- i. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- ii. Current sensing switches shall be used for running status for fans, pumps, and other miscellaneous motor loads.
- iii. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- iv. Acceptable manufacturers: Veris Industries

c. Low Temperature Limit Switches

- i. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
- ii. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
- iii. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

d. Differential Pressure Switches

- i. Air type: Shall be diaphragm actuated type with a single-pole, double-throw, snap-acting switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Electrical rating shall be 6.0 amps at 120 VAC. Pressure range and temperature limits shall be suitable for the application. A switch shall be utilized in conjunction with static pressure probes when utilized across filters, and a static pressure probe on the low side and a velocity probe on the high side when utilized across a fan.
- ii. Water type: Shall be diaphragm-actuated type with a single-pole, double-throw snap-acting switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. The switch shall be utilized in conjunction with shut off valves on the low and high sides of the switch to allow for ease of service.

2.3 OUTPUT DEVICES

A. Actuators

1. General Requirements

- a. Damper and valve actuators shall be electronic, as specified in the System Description section.

2. Electronic Damper Actuators

- a. Electronic damper actuators shall be direct shaft mount.
- b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as

required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external, adjustable stops to limit the travel in either direction, or a gear release to allow manual positioning.

- c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

B. Control Dampers

- 1. The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.
- 2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is enough of its close-off pressure drop to shift the characteristic curve to near linear.
- 3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and

flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

4. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Ruskin CD50, and Vent Products 5650.
5. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are Ruskin CD36, and Vent Products 5800.
6. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays

1. Control Pilot Relays
 - a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
 - b. Mounting Bases shall be snap-mount.
 - c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
 - d. Contacts shall be rated for 10 amps at 120VAC.
 - e. Relays shall have an integral indicator light and check button.
 - f. Acceptable manufacturers: Potter and Brumfield, RIB

2.4 MISCELLANEOUS DEVICES

A. Local Control Panels

1. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices such as relays, transducers, and so forth that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All panel wiring shall be to and from terminal strips. The use of wire nuts for connection of wiring to or from a common point is not acceptable.
4. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
5. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
6. All wiring shall be neatly installed in plastic trays or tie wrapped.
7. All wiring shall be identified.
8. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10%-line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.

7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

C. Thermostats

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. The finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

D. Lexan Thermostat Guards

1. All thermostats located in public and non supervised areas shall be fitted with tamperproof Lexan guards.

E. CO2 Sensors

1. Where shown on the drawings, CO2 sensors shall have the following features:
 - a. Jumper select able : 0-20mA, 4-20mA & 0-10VDC output
 - b. Liquid Crystal Display
2. The CO2 sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:
 - a. Zone carbon-dioxide
3. The CO2 shall transmit the information back to the controller via jumper selectable 0-20mA, 4-20mA & 0-10VDC output signals.
 - a. The CO2 sensors shall provide a maximum output current of 25mA; Maximum output voltage of 12.5V.
 - b. The CO2 sensors shall be FCC compliant to CFR47 Part 15 subpart B Class A.

4. The CO2 Sensors shall be available with
 - a. CO2 response time (0-63%) of 1 minute
 - b. Less than 0.083% of full scale/F° temperature dependence of CO2 output
 - c. Long term CO2 stability $\pm 5\%$ of full scale for 5 years
 - d. CO2 measurement accuracy of $\pm (40\text{ppm} + 2.0\%$ of reading)
 - e. CO2 non-linearity of less than 1.0% of full scale
5. The CO2 Sensors may include the following items:
 - a. Relay output module
 - b. Liquid Crystal Display module
 - c. Analog temperature module with linear 0-10VDC output for 32-122F

PART 3 – PERFORMANCE / EXECUTION

3.1 BMS Specific Requirements

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. Users shall access the various system schematics via a graphical penetration scheme and/or menu selection.
3. The Temperature Control Contractor shall coordinate all graphics with final room signage.
4. Custom Reports:
 - a. Provide custom reports as required for this project:

5. Actuation / Control Type
6. Primary Equipment
 - a. Controls shall be provided by the equipment manufacturer as specified herein.
 - b. All damper and valve actuation shall be electric.
7. Roof Top Unit Equipment
 - a. All roof top units shall be controlled with a HVAC-DDC Controller
 - b. All damper and valve actuation shall be electric.

3.2 Installation Practices

- A. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
- B. Where Class 2 wires are in concealed and accessible locations - including ceiling return air plenums, approved cables not in raceway may be used provided that:
 1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
 2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
- C. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- D. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.

- E. All wire-to-device connections shall be made at terminal blocks or terminal strips. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- F. The maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.
- G. All wiring shall be installed at continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- H. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
- I. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.
- J. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.
- K. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- L. Adhere to Division 26 requirements for installation of raceway.
- M. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- N. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.3 Training

- A. The BMS contractor shall provide the following training services:

1. 40 Hours of on-site training broken down into 4-hour sessions by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4.1 Acceptance

- A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

4.5.1 Software License

- A. The Owner shall be the named license holder of all software associated with all incremental work on the project(s). The owner, or his appointed agent, shall determine which organizations to be named in the “**orgid**” of all Niagara Framework™ and BAS system software licenses and programming tools required for ongoing system maintenance and reprogramming.

END OF SECTION 230900

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SECTION 230910 - VARIABLE FREQUENCY DRIVES

PART 1-GENERAL

1.1 SCOPE

- A. This specification describes the electrical, mechanical, environmental, agency and reliability requirements for three phase, adjustable frequency drives as specified herein and as shown on the contract drawings. Drives shall be furnished and mounted as shown on plans for pumps and shall be mounted on the air handling units. Drives shall be provided to Air Handler Unit manufacturer for mounting at factory. Drives used throughout the project site shall be provided by the same manufacturer for all applications (fans and pumps).

1.2 REFERENCES

- A. The variable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of IEC, UL, CUL, NEC, IEEE, ANSI, and NEMA.

1.3 SUBMITTALS - FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Architect.
 - 1. Dimensioned outline drawing.
 - 2. Schematic diagram.
 - 3. Power and control connection diagrams.
 - 4. Inverter efficiency and power factor curves.
 - 5. Performance curves.
 - 6. Sustentative data for Mean Time Between Failure (MTBF).

1.4 QUALIFICATIONS

- A. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly, such as bypass contactors when specified.
- B. For the equipment specified each drive shall be UL listed.
- C. Audible motor drive noise shall be within 5 db of across line noise operation.

1.5 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall include the following information:
 - 1. Instruction books

2. Recommended renewal parts list.
3. Drawings and information required by section 1.03.

1.6 WARRANTY

- A. All equipment shall be warranted for one year on all labor and materials.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Cutler-Hammer
- B. Allen-Bradley
- C. Toshiba
- D. ABB
- E. Reliance Electric
- F. Danfoss
- G. Square D
- H. Trane
- I. Yaskawa

Naming specific vendors does not imply acceptance of their standard products nor relieve them from meeting these specifications in their entirety.

2.2 ELECTRONIC REQUIREMENTS

- A. Each drive shall be microprocessor based, fully transistorized with 3 phase, full wave diode bridge input, and pulse-width-modulating sine-coded output waveform.
- B. Output transistors shall be of the Insulated Gate Bipolar Transistor (IGBT) type.
- C. Minimum 20 years MTBF required.
- D. Maximum switching frequency of 15 KHZ.
- E. Displacement power factor shall be 0.98 or better over the entire operating frequency and load range.
- F. Service Factors on belt driver sets - 1.35 minimum

- G. Provide multiple V belts on fan motors > 5 HP

2.3 PROTECTIVE FEATURES

- A. Drive enclosure shall be NEMA 1 and shall be wall-mount or free standing as indicated on the Drawings.
- B. Controlled acceleration and deceleration shall be adjustable from 3 to 600 seconds. Current limits shall prevent overflow trips.
- C. Minimum switching frequency shall be adjustable from 0 to 100 percent of base frequency.
- D. Maximum switching frequency shall be adjustable from 110 to 0 percent of base frequency.
- E. Automatic boost for 100 percent starting torque.
- F. Hand-off-auto switch mounted in front door of mounting enclosure.
- G. Fault contact for remote indication.
- H. Contact closure for remote indication that drive is operating.
- I. Automatic restart on fault that is programmable for 0 to 5 restarts.
- J. Minimum of 2 critical frequency avoidance points with programmable deadband.
- K. Output signal for motor speed shall be 0 to 10 vdc or 4-20 milliamp.
- L. Output voltage regulation.
- M. Continued operation of drive at 80 percent of last speed reference input if control command is lost.

2.4 OPERATION PROTECTION

- A. Current limit control for protection against normal transients and surges from incoming power lines, grounding systems, or runaway incoming speed reference signal.
- B. Protection from phase-to-phase and phase-to-ground faults.
- C. Torque limit control.
- D. Capabilities to start into a spinning load and wind milling operation.
- E. Instantaneous overcurrent trip to monitor peak currents and provide shutdown without component failure.

- F. Input line reactors with a minimum of 3 percent rating on all incoming phase lines.
- G. DC link choke to reduce current and voltage harmonics reflected to the AC power supply.

2.5 OPERATING CONDITIONS

- A. Unit shall comply to the following operating conditions:
 - 1. Line voltage: +10 percent, -10 percent of rating.
 - 2. Line frequency: + or - 5 percent
 - 3. Overload: 100 percent
 - 4. Ambient temperature: 0 degrees to 40 degrees C.
 - 5. Altitude: 3,300 feet or less
 - 6. Atmosphere: 95 percent relative humidity, noncondensing
 - 7. Efficiency: 97 percent at 100 percent load, 100 percent base speed. 80 percent at 12.5 percent load, 80 percent speed.
 - 8. Fundamental power factor shall be 0.98 at all speeds and loads.
- B. Digital operator/keypad is required and shall include the following features:
 - 1. Motor speed indication, in RPM, percent speed, or frequency (Hz)
 - 2. Speed reference signal
 - 3. Alpha-numeric fault trip annunciation
 - 4. Output current
 - 5. Output power
 - 6. Output voltage
 - 7. Bus voltage
- C. Indicator lights as follows:
 - 1. Power on light
 - 2. Run light
 - 3. VFD trip light
 - 4. External fault light.

- D. The mechanical contractor shall require a sheave change so that the fan motor is producing its full rated horsepower at a VFD speed of 100%.
- E. The variable speed pumps and fans shall be factory balanced throughout the entire range of operation.

2.6 OPTIONAL FEATURES TO BE INCLUDED IN THE VFD'S

- A. HMCP or thermal magnetic breaker to provide a disconnect means. Operating handle shall protrude from the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. This shall be defeatable by maintenance personnel.
- B. Three contactor bypass shall include a drive input disconnect, a VFD input isolation contactor, bypass contactor and a VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor overcurrent relays. The complete bypass system (Inverter-Off-Bypass) selector switch, and inverter/bypass pilot lights shall be packaged with the VFD. The unit may be set up for Manual bypass operation upon a VFD trip.
- C. AC output contactor to provide a means for positive disconnection of the drive output from the motor terminals.
- D. Laminated plastic or steel nameplate engraved with user's identifying name or number for oversize enclosures.
- E. 120 Vac control to allow VFD to interface with remote dry contacts.
- F. Motor overcurrent relay to provide motor overcurrent sensing of a given level of load current.
- G. All three phase motors shall be protected with Phase Loss protection. Protection shall be provided by the electrical systems, built-in protection, or by protection built into a Variable Frequency Drive.

PART 3-EXECUTION

3.1 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 - 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.

2. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The Variable Frequency Drive shall trip electronically without device failure.
 3. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
 4. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.2 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Architect or authorized service representative to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD's on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
1. Inspection and final adjustments.
 2. Operational and functional checks of VFDs and spare parts.
 3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.
- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.3 WARRANTY/TRAINING

- A. Manufacturer shall warrant complete drive system for a period of one (1) year.
- B. A factory trained representative shall provide a minimum of 8 hours on-site training to owner selected personnel on the operation and maintenance of each drive installed. This training shall be videotaped, with two (2) copies provided to the owner.

END OF SECTION 230910

SECTION 230993 – SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 DEFINITIONS

- A. BAS – Building Automation System.
- B. BASC – Building Automation System Contractor (Also may be called ATC (Automatic Temperature Control) Contractor).
- C. DDC – Direct Digital Control.
- D. MOD – Motor Operated Damper.
- E. NSB – Night Setback.
- F. NSU – Night Setup.
- G. SAF – Supply Air Fan
- H. EAF – Exhaust Air Fan
- I. SA – Supply Air

1.3 GENERAL

- A. Control points listed in this section shall be considered minimums.

PART 2 – PRODUCTS

- A. N/A

PART 3 – EXECUTION

- A. SEQUENCE TO BE DEFINED IN FINAL SUBMISSION

END OF SECTION 230993

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SECTION 232113 - HVAC PIPING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. HVAC piping.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. Follow manufacturers requirements for installation.
- B. Welding procedures per ANSI/ASME Section 9, AWS D10.9 and D1.1 and the National Certified Pipe Welding Bureau.
- C. Brazing procedures per ANSI B31.5 and the ASME Boiler and Pressure Vessel Code SFA-5.8, Section II.
- D. Soldering procedures per ANSI B16.18.
- E. Comply with ANSI B31 pressure code for pressure piping.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 HVAC PIPING

- A. Heating, Chilled, Supply and Return Piping.
 - 1. Black steel piping
 - a. Piping shall be standard weight black steel for 2-1/2 inch and smaller per ASTM A53 or A120. Fittings shall be class 125 cast iron threaded per ANSI B16.4.
 - b. Piping shall be standard weight black steel for 3 inch and larger per ASTM A53 or A120. Fittings shall be butt welded.
 - 2. Copper piping
 - a. Piping 2-1/2 inches and smaller shall be type L copper per ASTM B88. Fittings shall be wrought copper per ANSI B16.22.

3. IPS Grooved Piping System
 - a. Grooved mechanical pipe coupling, fittings, valves, and other grooved components may be used as an option to weld, threading, or flanged methods. All grooved components shall be of the one manufacturer and conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B31.9, ASME, UL/ULC, FM, IAPMO or BOCA. Grooved end product manufacturer to be ISO-9001 certified. Grooved coupling shall meet the requirements of ASTM F-1476.
 4. Copper press fitting may be used as an option per ASTM B16.18 or ASTM B16.22. O-rings shall be EPDM.
- B. Air Conditioning Condensate and Auxiliary Drain Piping
1. Piping shall be Schedule 40 PVC with solvent joints per ASTM D2665, D2564, D2665.
 2. In return air plenums and through fire walls, piping shall be type L copper per ASTM B88. Fittings shall be wrought copper per ANSI B16.22

PART 3-EXECUTION

3.1 INSTALLATION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- C. Provide pipe hangers and supports in accordance with Section 23 05 29 unless indicated otherwise.
- D. Use ball or butterfly valves with memory stop for shut off and to isolate equipment, part of systems, or vertical risers.
- E. Use ball or butterfly valves with memory stop for throttling, bypass, or manual flow control services.
- F. Use spring loaded check valves on discharge of chilled water pumps.
- G. Use butterfly valves in heating and chilled water systems for all piping 2- 1/2" and larger. Use ball valves in heating and chilled water systems for all piping 2" and under.
- H. Use only butterfly valves in chilled water systems for throttling and isolation service.
- I. Use lug end butterfly valves to isolate equipment.

- J. Use 3/4 inch ball valves with hose end and cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- K. Install in accordance with manufacturer's instructions.
- L. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- M. Route piping in orderly manner and maintain gradient.
- N. Install piping to conserve building space and not interfere with use of space and other work.
- O. Group piping whenever practical at common elevations.
- P. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- Q. Provide clearance for installation of insulation and access to valves and fittings.
- R. Provide 24"x 24" access doors where valves are not exposed and are installed where hardboard ceiling occurs.
- S. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- T. Install valves with stems upright or horizontal, not inverted.
- U. Do not attach pipe supports to underside of roof deck.
- V. Metallic pipe or tubing exposed to corrosive action, such as soil conditions or moisture, shall be protected in an approved manner.

END OF SECTION 232113

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SECTION 232123 - HYDRONIC PUMPS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Base-mount end-suction pumps.
- B. In-line circulators

1.2 QUALITY ASSURANCE

- A. The standard for construction shall be ASME B31.9.

1.3 SYSTEM DESCRIPTION

- A. Impellers shall be sized for a maximum diameter not to exceed 85 percent of the selected pump's largest diameter.
- B. Each pump shall be selected for non-overloading operation throughout its curve.
- C. Each pump shall be provided with high efficiency motors.
- D. All three- phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built in protection, or by protection built into a variable speed drive.

1.4 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include pump performance curves.

1.5 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 BASE-MOUNT END-SUCTION PUMPS

- A. Manufacturers
 - 1. Taco
 - 2. Bell & Gossett
 - 3. Aurora
 - 4. Grundfos

5. Armstrong

- B. Each pump will be single stage, base-mounted, end-suction design with cast iron casing, cast-bronze impeller, and bronze fitted construction.
- C. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- E. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- F. Seal: Carbon rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.
- G. Performance: Pumps shall be size and capacity scheduled on drawings.
- H. The pump and motor shall be mounted on a common baseplate of heavy structural steel.

2.2 IN-LINE CIRCULATORS

A. Manufacturers

- 1. Taco
- 2. Bell & Gossett
- 3. Aurora
- 4. Grundfos
- 5. Armstrong

- B. Each pump will be vertical, centrifugal, single stage, design with cast iron casings and bronze impellers.
- C. Casing: Cast iron, with flanged pump connection.
- D. Impeller: Cast bronze, keyed to shaft.
- E. Bearings: Permanently lubricated bearing cartridge.
- F. Shaft: Alloy steel with cupro-nickel sleeve, integral thrust collar.
- G. Seal: Carbon rotating against a stationary, ceramic seat, 250 degrees F maximum continuous operating temperature.
- H. Drive: Flexible coupling.
- I. Performance: Pumps shall be size and capacity scheduled or listed on drawings.

- J. Direct-mounted motor with lifting and supporting lugs.

PART 3-EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install all pumps in accordance with manufacturers requirements.
- B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers at pumps. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and pump suction fitting (as sized on drawings) on pump suction, and triple duty valve (as sized on drawings) on pump discharge.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Check, align, and certify alignment of base mounted pumps prior to start-up.
- H. Install base mounted end suction pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place.
- I. Lubricate pumps before start-up.
- J. Provide flexible braided connections for pump inlet and outlet. Three flexible type grooved joint couplings may be used in lieu of flexible connectors at equipment connections in applicable piping systems. The couplings shall be placed in close proximity to the vibration source. Basis of Design: Victaulic Company. Victaulic Series 380/381/382 Vibration Isolation Pump Drops (VIPD) may be used around pump assemblies where applicable.

3.3 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for a total of four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Refrigerant piping and accessories.

1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. ASME B31.5 Refrigeration Piping latest edition.
- B. UL 207 Refrigerant Containing Components and Accessories.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 COMPONENTS

- A. Piping: Type ACR hard copper tubing with wrought copper fittings and brazed joints.
- B. Seamless copper tube (annealed copper) in pre-insulated line-sets
 - 1. UL listed to 700 psi
 - 2. Meets ASTM B1003, ASTM C534, and ASTM E-84
- C. Valves
 - 1. Packed angle valve.
 - 2. Solenoid valve.
 - 3. Refrigerant check valve.
 - 4. Thermal expansion valve.
 - 5. Pressure relief valve.
 - 6. Pressure regulating valve.
 - 7. Hot gas bypass valve.
 - 8. Suction accumulator.

- D. Moisture indicators.
- E. Replaceable type filter/dryer assemblies with three valve by-pass.
- F. Flexible piping connectors.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Provide filter/dryer assemblies, moisture indicators, thermal expansion valve and solenoid valves for each refrigeration circuit.
- B. Pressure test refrigerant piping system at 300 psi for high side and 150 psi for low side. Maintain pressure for a minimum of 24 hours.
- C. Leak test piping and joints with an electronic or halide leak detector.
- D. Evacuate entire system with an approved high vacuum pump system to 500 microns.
- E. Purge piping while brazing.

END OF SECTION 232300

SECTION 232500 - HVAC WATER TREATMENT

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Closed water treatment system for heating hot water and, chilled water systems.

1.2 SUBMITTALS

- A. Submit shop drawing and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting catalog data, specification data, dimensional and operational data, wiring requirements with diagram, chemical specification data, and warranty data.

1.3 QUALITY ASSURANCE

- A. Chemicals shall meet all state and local pollution control regulations.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.
- B. Provide a 1-year chemical service program including testing and required materials and additives.

PART 2-PRODUCTS

2.1 SYSTEM COMPONENTS

- A. Bypass Shot Feeders: Cast iron or steel, 1.8-gallon capacity minimum, 125-psig working-pressure rating.
- B. Chemical Solution Tanks: 50 gallon.
- C. Chemical treatment test equipment
 - 1. Water test kit with spare reagents.
 - 2. Conductivity meter that compensates for differences in temperatures and analog meter.
- D. Chemicals
 - 1. Provide a minimum of 1 year supply.
 - 2. Include all MSDS sheets for chemicals provided.
- E. Pre-cleaning and flushing materials: Provide chemicals produced specifically for use in cleaning piping systems after installation and prior to being placed into operation.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install shot feeder with 2 valve bypass.
- C. Hydronic systems shall not be operated for any reason prior to complete flushing and charging with appropriate chemicals.

3.2 HYDRONIC SYSTEMS FLUSHING AND PRE-CLEANING

- A. The following procedures is for flushing and pre-cleaning
 1. Determine the metallurgy of the system
 2. By-pass all HVAC equipment
 3. Determine the exact system volume. This may be accomplished by filling the system through a water meter or salt test.
 4. With all areas open to flow, add system cleaner through the By-Pass Filter Feeder or pump per manufacturer's recommendations.
 5. Cleaning and flush rates must be at a minimum of 6 ft/sec through the piping or maximum flow rate of the system.
 6. First flush the system to remove as much suspended material as possible with clear water.
 7. Second, cleaning shall maintain total alkalinity of 3000 ppm for twenty-four (24) to thirty-six (36) hours.
 8. Third, flush system until pH and Alkalinity return to make-up water levels and drain.
 9. Fourth, fill system with OSDM-compliant clean water with a water chemistry (pH, alkalinity, etc.) and make-up that meets equipment water quality requirements.
 - a. If the system is drained of water and a heat transfer solution added, a quality corrosion inhibitor shall be added to the system to protect against flash rust while the system is drained. Please consult your water treatment professional for recommendations.
 10. Simply draining the loop and refilling with fresh water is not permitted. The loop needs to be flushed by adding fresh water and draining dirty water continuously. This procedure will help prevent foulants from dropping out on the pipe surfaces.

3.3 WATER SERVICE PROGRAM

- A. The water treatment contractor shall provide maintenance and consulting services for 1 year from date of acceptance of system by the Owner. Minimum service requirements shall include:

1. Monthly sample and testing
2. Additional chemical if needed
3. Side stream filter change
4. Testing of: PH, alkalinity, conductance, inhibitor, microbiological dip slide, and % glycol
5. Visual check of system
6. Written report documenting all of the items above.

END OF SECTION 232500

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SECTION 233113 - LOW-PRESSURE DUCTWORK

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Low pressure supply sheet metal ductwork., (2-inch wg pressure class).
- B. Low pressure return, relief and exhaust sheet metal ductwork., (2-inch wg pressure class).
- C. Duct insulation liner. Only use where indicated on drawings.
- D. Low pressure aluminum ductwork.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Submittals are required and shall include 1/4 inch scale layout shop drawings showing duct location, sizes, duct fittings, gauges, sizes, welds, volume dampers, elevations and air flow quantities for each air terminal device. Electronic drawing files of floor plans and structural plans are available from the Architect/Engineer upon request. Submittal shall be approved prior to start of work on any system.

1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181.
- C. NAIMA AH124-94: Fibrous Glass Duct Liner Standard.
- D. NFPA 90A and 90B.
- E. ASHRAE Handbook, HVAC Systems and Equipment.
- F. Ductwork shall be sealed and leak tested as required by ASHRAE standard 90.1

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 COMPONENTS

- A. Supply air, return air, relief air and exhaust air (except shower rooms) shall be galvanized steel lock-forming quality ASTM A 653/A 653/M, G90 (Z275) coating designation; milli-phosphatized finish for surfaces of ducts exposed to view. Gauges shall be per the latest issue of SMACNA for listed pressure requirements.

1. Provide Class A seals for all joints.
 - a. Manufacturers
 1. Hardcast
 2. Benjamin Foster
 3. United McGill
 - b. Non – hardening, water resistant, fire resistant, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
 2. Hanger Rod: ASTM A36; steel threaded both ends, threaded one end, or continuously threaded.
- B. Shower exhaust ductwork shall be aluminum construction conforming to ASTM B 209 Alloy 3003, Temper H14, Gauges shall be per the latest issue of SMACNA for listed pressure requirements. Seal all joints liquid-tight.
- C. Flexible duct liner shall be a minimum of 1 inch thick and shall be applied in accordance with the latest addition of the SMACNA's Duct Liner Application Standard. All dimension shown on the plans are inside duct dimension and do not include the dimension of the duct liner.

2.2 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide double wall turning vanes of preformed metal with glass fiber insulation.
- C. Increase duct size gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

2.3 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards – Metal and flexible and construct of galvanized steel for operating pressures indicated with galvanized steel angle reinforcement.
- B. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Provide clear wire glass observation ports, minimum 6X6 inch size.

2.4 DUCT LINING

- A. Line ductwork with duct liner as indicated.
- B. Duct lining shall be 1" thick installed with adhesive and clip fasteners per manufacturer's recommendations.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Seal class 'A' for all ductwork above 2" pressure class.
- C. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Use double nuts and lock washers on threaded rod supports.
- G. Install 1" x 18 gauge hanger straps or trapeze hangers. Ducts shall not be supported from metal ducts.
- H. The contractor shall install the ducts and flues indicated on the drawings making all necessary changes in cross sections, offset, etc. whether or not same specifically indicated. If a duct cannot be run as shown on the drawings, the Contractor shall install the duct between the required points by any path available, subject to approval of the Architect
- I. Install sheet metal sleeves for all ductwork passing through floors, wall, partitions, etc. Sleeves for insulated duct shall be large enough to allow insulation to pass through a sleeve. A 3" high concrete curb shall be provided around all duct openings through equipment room floors, floors in wet areas, and floor that are slab on grade. Refer to structural details for construction information.
- J. All vertical ducts or risers shall be self-supporting and shall be complete in themselves, no single thickness partitions between ducts being permitted.
- K. Provide "flexible" connections as noted on drawings between ducts and fans with 1" slack.
- L. No pipes or other obstructions shall pass through air ducts.

- M. All ducts at ceilings shall be run in such a manner as to maintain a maximum headroom in all rooms and corridors.
- N. Ducts must be installed at such times as the construction alterations of the building will permit or as required by the Architects.
- O. The Sheet Metal Contractor shall set all automatic louver dampers furnished by the Temperature Control Contractor which includes pressure relief dampers, and combustion air dampers.

Note: Where ducts pass through fire stops or fire walls, provide a steel sleeve as detailed on the drawings and required by NFPA Bulletin No. 90A. There shall be no openings between the steel sleeve and the fire partition.

- P. Sheet Metal Contractor shall certify by letter to the Architect that all fire dampers have been installed as called for on the drawings and that all fire dampers are in proper operating condition.
- Q. Connect terminal units to supply ducts with two feet maximum length of high pressure, flexible duct. Do not use flexible duct to change direction.
- R. Connect diffusers to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp except where noted on drawings to use double-wall insulated spiral duct.
- S. Connect flexible ducts to metal ducts with adhesive, plus stainless- steel draw bands. Maximum length shall be 5'-0" with no more than two 90 degrees elbows as installed. Connect to ducts with fittings with integral air extractor and balancing damper.
- T. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
- U. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 SCHEDULES

A. Ductwork Material Schedule

Low Pressure Ductwork

Low pressure rectangular ducts shall be made up of the following gauge metal:

Ducts up to and including 12"	- #26 U.S.S. Ga.
Ducts 13" to 30"	- #24 U.S.S. Ga.
Ducts 31" to 48"	- #22 U.S.S. Ga.
Ducts 49" to 72"	- #20 U.S.S. Ga.
Ducts over 72"	- #18 U.S.S. Ga.
Plenums	- #18 U.S.S. Ga.

The sizes given above are the greatest dimensions or longest side of duct.

Construct all low pressure duct to SMACNA 2" W.G. pressure class.

Low pressure rectangular ducts shall be reinforced with galvanized angles conforming to the following schedule.

Dimensions of longest side Of duct, Inches	Reinforcing and Spacing
Up to and including 18"	None Required
Duct 19" to 42"	1"x1"x1/8" @ 60 in.
Ducts 43" to 48"	1 1/2" x 1 1/2" x 1/8" @ 60"
Ducts 49" to 60"	1 1/2" x 1 1/2" x 1/8" @ 48"
Ducts 61" to 84"	1 1/2" x 1 1/2" x 1/8" @ 24"

- B. Round low pressure duct shall be longitudinal seam round duct, and fittings.
1. Manufacturers:
 - a. United Sheet Metal
 - b. Semco
 - c. Lindlab Spiral 7 Shop Fabricated Fittings

END OF SECTION 233113

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SECTION 233114 - MEDIUM-PRESSURE DUCTWORK

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Medium-pressure round or flat oval supply (3- inch wg pressure class) sheet metal ductwork.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Shop drawings shall include 1/4 inch scale layout shop drawings showing duct location sizes, duct fittings, gauges, sizes, welds, volume dampers, elevations and air flow quantities for each air terminal device. Electronic drawing files of floor plans and structural plans are available from the Architect upon request. Submittals shall be approved prior to start of work on any system.

1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181.
- C. NFPA 90A and 90B.
- D. ASHRAE Handbook, HVAC Systems and Equipment.
- E. Ductwork shall be sealed and leak tested as required by ASHRAE standard 90.1, and as specified herein.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. United McGill
- B. Semco
- C. Lindab Spiral 7 Shop fabricated Fittings

2.2 COMPONENTS

- A. Supply air ductwork shall be spiral seam round or rectangular medium pressure, duct work constructed of galvanized steel lock-forming quality ASTM A 653/A 653/M, G90 (Z275) coating designation; milli-phosphatized finish for surfaces of ducts exposed to

view. Gauges shall be per the latest issue of SMACNA for listed pressure requirements, or as listed below, whichever is more stringent.

- B. All round medium pressure ducts shall be galvanized steel spiral conduit of lock seam construction. Fittings shall be all welded 20 ga. Steel construction for tight slip fit with spiral. All connections from mains to branches or to flexible duct shall be as shown on the drawings and per schedule. Joints between fittings and conduit shall be made with synthetic rubber sealing compound, mechanically fastened with drive screws. All spiral ducts and fittings shall be as manufactured by United Sheet Metal Company, or Semco. All Medium pressure ductwork shall be constructed to SMACNA 3" W.G. pressure class.

- C. Round medium pressure ducts shall be constructed of the following gauge metal:

Diameter	Spiral Seam Gauge	Longitudinal Seam Gauge
3 through 14 inches	26	24
15 through 26 inches	24	22
27 through 36 inches	22	20
37 through 50 inches	20	20
51 through 60 inches	18	18
61 through 84 inches	18	16

- D. Round medium pressure fittings shall be constructed with continuous welds of the following gauge metal:

DIAMETER	GAUGE
3" to 36"	20
38" to 50"	18

- E. Rectangular medium pressure ducts shall be constructed of the following gauge metal:

Duct up to & including 12"	- #22 U.S.S. Ga.
Ducts 13" to 30"	- #20 U.S.S. Ga.
Ducts 31" to 48"	- #18 U.S.S. Ga.
Ducts 49" to 60"	- # 16 U.S.S. Ga.

- F. All supply air duct up to VAV boxes shall be medium pressure ductwork.

- G. Sizes given are greatest dimensions or longest side of ducts. All ducts up to 16" shall be constructed with drive joints and all joints sealed. All ducts over 16" shall be constructed using angles at each joint bolted together to the companion angle with the sheet metal turned up on the leg of the angle and sealed. Angles shall be located 4'-0" on centers of sizes scheduled below.

Duct Size	Angle Size
16" to 30"	1 ½" X 1 ½" X 18"
Over 30"	2 "X 2" X 3/16"

All angles shall be sheared or sawed.

- H. Specially construct duct for medium pressure air distribution with all seams locked and rolled and all joints sealed.
- I. Test all medium pressure ductwork per SMACNA leakage test manual to SMACNA leakage class 6 for rectangular metal and SMACNA leakage class 3 for round metal.

2.3 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible and construct of galvanized steel for operating pressures indicated with galvanized steel angle reinforcement.
- B. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Provide clear wire glass observation ports, minimum 6X6 inch size.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Seal class 'A' for all ductwork above 2" pressure class.
- C. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can and spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Use double nuts and lock washers on threaded rod supports.
- G. Install 1" x 18 gauge hanger straps or trapeze hangers. Ducts shall not be supported from metal ducts.
- H. The contractor shall install the ducts and flues indicated on the drawings making all necessary changes in cross sections, offset, etc. whether or not same specifically indicated. If a duct cannot be run as shown on the drawings, the Contractor shall install the duct between the required points by any path available, subject to approval of the Architect
- I. Install sheet metal sleeves for all ductwork passing through floors, wall, partitions, etc. Sleeves for insulated duct shall be large enough to allow insulation to pass through a sleeve. A 3" high concrete curb shall be provided around all duct openings through equipment room floors, floors in wet areas, and floors that are slab on grade. Refer to

structural details for construction information.

- J. All vertical ducts or risers shall be self-supporting and shall be complete in themselves, no single thickness partitions between ducts being permitted.
- K. Provide "Flexible" connections as noted on drawings between ducts and fans with 1" slack.
- L. No pipes or other obstructions shall pass through air ducts.
- M. All ducts at ceilings shall be run in such a manner as to maintain a maximum headroom in all rooms and corridors.
- N. Ducts must be installed at such times as the construction alterations of the building will permit or as required by the Architects.
- O. The Sheet Metal Contractor shall set all automatic dampers furnished by the Temperature Control Contractor which includes pressure relief dampers, outside air dampers and return air dampers.

Note: Where ducts pass through fire stops or fire walls, provide a steel sleeve as detailed on the drawings and required by NFPA Bulletin No. 90A. There shall be no openings between the steel sleeve and the fire partition.

- P. Sheet Metal Contractor shall certify by letter to the Architect that all fire dampers have been installed as called for on the drawings and that all fire dampers are in proper operating condition.
- Q. Connect terminal units to supply ducts with two feet maximum length of high pressure, flexible duct. Do not use flexible duct to change direction.
- R. Connect flexible ducts to metal ducts with adhesive, plus stainless- steel draw bands. Maximum length shall be 5'-0" with no more than two 90 degrees elbows as installed. Connect to ducts with fittings with integral air extractor and balancing damper.
- S. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction duct from entering ductwork system.

END OF SECTION 233114

SECTION 233115 - FLEXIBLE DUCTWORK

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Flexible insulated HVAC ductwork.
- B. Flexible ductwork joint connections.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Shop drawings shall include material pressure ratings and dimensions.

1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL 181
- C. NFPA 90A and 90B.
- D. ASHRAE Handbook, HVAC Systems and Equipment.
- E. UL 191.
- F. Ductwork shall be sealed and leak tested as required by ASHRAE standard 90.1.

PART 2-PRODUCTS

2.1 MANUFACTURERS – FLEXIBLE DUCT CONNECTORS

- A. Duro Dyne
- B. Ventfabrics
- C. Elgen
- D. Ductmate

2.2 COMPONENTS

- A. Flexible Duct Connectors
 - 1. Minimum 30 ounce neoprene coated fabric secured by bolted angles or band iron.
 - 2. Metal to metal contact shall not be permitted.

2.3 FLEXIBLE DUCTS

- 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. Flexmaster U.S.A., Inc.
 - 2. Thermaflex.
 - 3. Hart & Cooley Commercial.
- B. Non-insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
 - 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.
- C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; fire resistive vapor-barrier film.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 175 deg F.
 - 4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.
- D. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; fire resistive 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 20 to plus 210 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Provide the flexible connections at ductwork connections to vibrating or rotating equipment, including fans.
- B. Install in accordance with manufacturer's instructions.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Provide "Flexible" connections as noted on drawings between ducts and fans with 1" slack.
- E. No pipes or other obstructions shall pass through air ducts.

- F. All ducts at ceilings shall be run in such a manner as to maintain a maximum headroom in all rooms and corridors.
- G. Ducts must be installed at such times as the construction alterations of the building will permit or as required by the Architects.
- H. Connect diffusers to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.
- I. Connect flexible ducts to metal ducts with adhesive, plus stainless- steel draw bands. Maximum length shall be 5'-0" with no more than two 90 degrees elbows as installed. Connect to ducts with fittings with integral air extractor and balancing damper.

END OF SECTION 233115

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SECTION 233300 - DUCTWORK ACCESSORIES

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Backdraft dampers
- B. Manual volume dampers
- C. Fire dampers
- D. Turning vanes
- E. Duct access doors.
- F. Duct test holes.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Shop drawings shall include material, sizes, quantities, and dimensions.

1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181.
- C. NFPA 90A and 90B.
- D. ASHRAE Handbook, HVAC Systems and Equipment.
- E. Dampers shall meet the requirements of Ashrae standard 90.1.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 BACKDRAFT DAMPERS

- A. Manufacturers
 - 1. Ruskin
 - 2. American Warming
 - 3. Ampco

- 4. Greenheck
- B. Frames: Galvanized steel.
- C. Blades: Extruded aluminum.
- D. Blade Seals: Neoprene.
- E. Blade Axles: Galvanized steel.
- F. Tie Bars and Brackets: Aluminum.
- G. Return Spring: Adjustable tension for motor operated dampers only.
- H. Dampers: Counter-balanced for building pressure activation.

2.2 MANUAL VOLUME DAMPERS

- A. Manufacturers
 - 1. Ruskin
 - 2. United Sheet Metal
 - 3. Fabco
 - 4. Greenheck
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, and as indicated.
- C. Splitter Dampers:
 - 1. Material: Same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum ¼” diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- D. Single Blade Dampers: Fabricate for duct sizes up to with smallest dimension less than 12 inches.
- E. Multi-Blade Damper: Factory made of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble and edge crimped blades in prime coated or galvanized channel frame with suitable hardware; Use multi-blade dampers with smallest dimension 12” or larger.

- F. End Bearings: Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- G. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.3 FIRE DAMPERS

- A. Manufacturers
 - 1. Air Balance
 - 2. Ruskin
 - 3. Safe – Aire
 - 4. Prefco
 - 5. Greenheck
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated. Air Balance type 119 in medium pressure ductwork and type ML in low-pressure ductwork.
- C. Fire Dampers where either dimension is less than 24” in width or 12” in height, the unit size shall be based on inside frame dimension.
- D. Fire Dampers in medium pressure ductwork shall have 100% free area when open with frame and blades outside the duct area.
- E. Horizontal Dampers: Galvanized steel, 22 gauge frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- F. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for closure under air flow conditions.
- G. Multiple Blade Dampers: 16 gauge galvanized steel frame and blades, oil impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8” x 1/2” plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- H. Fusible Links: UL 33.

2.4 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, threaded or twist-on metal caps.

- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:

- 1. Titus Model AG 45
- 2. Anemostat Model DT
- 3. Carnes Model XRVA
- 4. Krueger

- B. Multi-blade device with blades attached to pivoting frame and bracket, steel construction, and worm drive mechanism with 18 inch long removable key operator.

2.6 MOUNTED ACCESS PANELS AND DOORS

A. Manufacturers:

- 1. Ruskin
- 2. Semco
- 3. United Sheet Metal

- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, and as indicated.

- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gasket and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

- D. All access doors in sheet metal ducts or casings shall be provided with latches, hinges and felt gaskets as manufactured by Ventfabrics, Inc., 5520 North Lynch Avenue, Chicago, Illinois, Duro Dyne or approved equal. All doors less than 4 sq.ft. in area shall have Series 100 Ventlock, doors from 4 sq.ft. to 8 sq.ft. in area shall have a Series 200 Ventlock; and doors larger than 8 sq.ft. in area shall have Series 300 Ventlock.

- E. Access doors to fire dampers for medium pressure duct system shall be located downstream of fire damper. Access section shall consist of access opening with double wall insulated door and shall serve as a vacuum relief valve.

- F. Access doors with sheet metal screw fasteners are not acceptable.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install manufactured products in accordance with manufacturer's instructions.
- B. Provide splitter dampers, manual volume control dampers and/or extractors at points on supply, return, and exhaust systems as required for air balancing.
- C. Provide fire dampers at locations indicated, where duct, outlets and inlets pass through fire rated components and where required by authorities having jurisdiction. Install per UL and manufacturers requirements with required perimeter mounting angles, sleeves, breakaway duct connections and sealing. Provide gentle transitions from adjacent ducts to dampers.
- D. Demonstrate resetting of fire dampers to authorities having jurisdiction and Owner's representative.
- E. Provide motorized shut-off dampers on exhaust fans or in exhaust ducts and in relief assemblies nearest to outside and where indicated.
- F. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- G. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, any motorized dampers, at splitter dampers, at relief dampers and at fire dampers. Provide minimum 12 x 12 inch size for hand access, 24 x 24 inch size for shoulder access. Size doors generously as the Architect will determine if doors are reasonable for intended access.
- H. Provide duct test holes where required for testing and balancing purposes.
- I. Transition ducts gently to allow installation of duct accessories if required.
- J. Provide architectural access doors and install in architectural entities whenever access is required for work of this section. Doors and installation to meet the approval of the Architect.
- K. Install negative pressure relief doors immediately downstream and a positive pressure relief access door upstream of all fire dampers (or other dampers subject to sudden closure). See Specification Section 23 33 00 for access door work.
- L. Installation of duct accessories in exposed ducts to be done for best aesthetics. Prime accessories, shafts, operators, linkages, etc.
- M. Provide openings in ductwork to accommodate rods, shafts, etc. and seal and insulate (if required).
- N. Locate accessories for proper operation and service.
- O. Provide turning vanes in all mitered ductwork 90 degree elbows.
- P. Provide duct mounted access doors and panels to all fire dampers, control damper, plenum housings.

END OF SECTION 233300

SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Centrifugal Roof Ventilator
- C. Centrifugal square In-line Fans

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Shop drawings shall include material, capacities, quantities, and accessories.

1.3 QUALITY ASSURANCE

- A. Sound Power Level Rating: AMCA 301.
- B. Performance Requirements: AMCA 210.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Greenheck
- B. Cook
- C. Penn/Barry
- D. Twin City

2.2 COMPONENTS

- A. Centrifugal Roof Ventilators
 - 1. Drive: Direct
 - 2. Housing: Spun aluminum.
 - 3. Fan Wheel: Aluminum hub and wheel, backward-inclined blades.
 - 4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, cast iron adjustable pitch pulley, and fan motor isolated from airstream.

5. Motor: Heavy duty, ball bearing type with overload protection.
6. Accessories:
 - a. Disconnect switch
 - b. Bird screens
 - c. Motor Operated Backdraft dampers
7. Roof Curb Configuration: Self-flashing without cant strip and with mounting flange.
8. Roof Curb Height: 12 inches standard above finished roof.

B. Centrifugal Square In-line Fan

1. Drive: Direct
2. Housing: Galvanized sheet metal.
3. Fan Wheel: Centrifugal, aluminum.
4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, adjustable pitch motor pulleys, motor insulated from airstream, belt guards.
5. Motors: Heavy duty, ball bearing type with overload protection.
6. Accessories:
 - a. Variable speed controller
 - b. Disconnect switch
 - c. Motorized backdraft dampers
 - d. Spring vibration isolators

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install per manufacturers requirements.
- B. Mount units on roof curbs to be furnished and set by mechanical contractor. Cutting of opening is by mechanical contractor. Flashing is by the general contractor.

3.2 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for a total of two (2) hours. These hours of training are to be "bankable hours" used

within one full warranty year.

- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 233416

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SECTION 233600 - AIR TERMINAL UNITS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Variable air volume reheat terminals.
- B. Fan-powered, variable air volume reheat terminals.

1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting the following:
 - 1. Product data indicating dimensions, weights, capacities, and materials.
 - 2. Static pressure requirements.
 - 3. Sound performance levels.
 - 4. Accessories.

1.3 QUALITY ASSURANCE

- A. Construction standard shall meet NFPA 90A.
- B. Product certification shall comply with ARI 880.
- C. Sound power level rating shall comply with AMCA 300, ASHRAE 68, and AMCA 301.
- D. Coil performance shall comply with ARI 410.
- E. Insulation standard shall comply with UL 181.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS:

- A. Titus (Basis of Design)
- B. Trane
- C. Metal-Aire
- D. Johnson Controls Inc.
- E. Tuttle & Bailey

F. Price

G. Envirotec

2.2 COMPONENTS

A. Single-Duct Reheat Terminal Units

1. Configuration: Volume-damper assembly inside unit casing.
2. Casing: Zinc-coated steel
3. Casing Lining: 1-inch thick, 1-1/2 pound density insulation with corrosion-resistant coating.
4. Air Inlets: Round or flat oval with integral air velocity sensor.
5. Volume Damper: cylindrical flow control device with 1% of damper nominal CFM at 4" W.G. differential.
6. Damper Position: Normally closed at 4" W.G. Differential.
7. Hot-Water Heating Coil: Copper tube and aluminum finned coil.
8. Velocity sensor: multi-point averaging type.
9. Controls: Electronic DDC controls.
 - a. Furnished and sent to terminal unit manufacturer for installation by BASC
10. Each unit shall include the following control accessories supplied by terminal unit manufacturer:
 - a. Flow Ring.
 - b. Disconnect switch
 - c. Mount controls in NEMA 250 Type 1 enclosure.
11. Each unit shall include the following control accessories supplied from Temperature Control Contractor to the box manufacturer for mounting at the factory.
 - a. Volume regulators with D.P. sensors and airflow probe.
 - b. VAV controller.
 - c. Damper actuator and damper
 - d. Control wiring associated with VAV box operation.

12. Temperature Control Contractor to furnish reheat coil automatic temperature control valve to mechanical contractor for installation by same.
13. Electrical contractor shall furnish and install 120- volt power wiring to the junction boxes noted on the Mechanical drawings. Temperature Control Contractor shall extend all low voltage wiring from transformers (by Temperature Control Contractor) to VAV boxes.

B. Fan-Powered Reheat Terminal Units

1. Configuration: Volume-damper assembly inside unit casing.
2. Casing: Zinc-coated steel
3. Casing Lining: 1-inch thick, 1-1/2 pound density insulation with corrosion-resistant coating.
4. Air Inlets: Round or flat oval with air velocity sensor.
5. Access: Removable panels with cam-lock fasteners.
6. Volume Damper: cylindrical flow control device with maximum airflow leakage of 1% of damper nominal CFM at 4" W.G. Differential.
7. Damper Position: Normally Closed
8. Fan: Series type unit located in acoustically lined plenum housing a direct-drive, forward-curved fan, and thermally protected PSC motor.
9. Hot-Water Heating Coil: Copper tube and aluminum finned coil.
10. Velocity sensor: multi-point averaging type.
11. Filter: Attenuating air inlet section complete with 1 inch filter rack.
12. Controls: Electronic DDC controls.
 - a. Furnished and sent to terminal unit manufacturer for installation by BASC
13. Each unit shall include the following control accessories supplied by equipment manufacturer:
 - a. Flow Ring.
 - b. Control relay for fan operation.
 - c. Reduced voltage transformer on the box.
 - d. Disconnect switch.
14. Each unit shall include the following control accessories supplied from Temperature Control Contractor to the box manufacturer for mounting at the factory.

- a. Volume regulators with D.P. sensors and airflow probe.
 - b. Fan Powered VAV controller.
 - c. Control wiring associated with fan powered box operation.
 - d. Fan SCR speed controller wired to motor for full variable speed control.
15. Temperature control contractor to furnish reheat coil automatic temperature control valve to mechanical contractor for installation by same.
16. Electrical contractor shall furnish and install 120 or 277 volt power wiring (as noted on the electrical drawings) to the fan powered box transformer and shall make final power wiring connections to the unit/transformer.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Startup and training to be provided by a factory-trained service technician.

3.2 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for a total of four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Return Air, Exhaust Air, and Transfer Air, Grilles and Registers.
- B. Supply Air Registers.
- C. Supply Air Diffusers.
- D. Egg Crate Return Air or Transfer Air Grilles.
- E. Heavy Duty Wall Return Air Grille or Register.
- F. Supply Air Linear Slot Diffusers
- G. High Capacity Drum Louvers
- H. Return Air Linear Slot grilles

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Shop drawings shall be scheduled by room number to include material, sizes, quantities, finishes, and accessories.

1.3 QUALITY ASSURANCE

- A. ASHRAE Standard 70 for performance testing.
- B. NFPA 90A for installation.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Titus
- B. Price
- C. Tuttle & Bailey

2.2 COMPONENTS

- A. Return Air, Exhaust Air, and Transfer Air, Grilles and Registers
 - 1. All aluminum construction.
 - 2. Angled louvers spaced 3/4" on center.
 - 3. One set of fixed louvers parallel to long dimension.
 - 4. Baked white enamel finish or powder paint white finish.
 - 5. Opposed blade volume damper (for registers).
- B. Supply Air Registers
 - 1. All aluminum construction.
 - 2. Double deflection louvers.
 - 3. Front and rear louvers, individually adjustable, horizontal to the front.
 - 4. Baked white enamel finish or powder paint white finish.
 - 5. Opposed blade volume damper for all registers.
- C. Plaque Face Supply Air Diffuser (Square or Round Face)
 - 1. Square Face: All aluminum construction.
 - 2. Round Face: All 18 gauge steel diffuser.
 - 2. Solid face panel with curved back pan designed for VAV usage.
 - 3. Opposed blade volume damper in accessible locations.
 - 4. Baked white enamel finish or powder paint white finish.
 - 5. Provide with equalizing grid.
 - 6. Provide insulation blanket on back pan for above ceiling installations.
 - 7. Provide border/frame for appropriate ceiling installation
- D. Perforated Ceiling Supply Diffuser
 - 1. All 18 gauge steel diffuser for flush face installation
 - 2. Perforated holes shall be 3/16" diameter minimum on 1/4" staggered centers and no less than 51% free area.
 - 3. Opposed blade volume damper in accessible location.

4. Solid one-piece stamped backpan.
 5. Baked white enamel finish or powder paint white finish.
 6. Provide with equalizing grid.
 7. Provide insulation blanket on back pan for above ceiling installations.
 8. Provide border/frame for appropriate ceiling installation
- D. Eggcrate Return Air Grille or Transfer Grille
1. 1/2 inch by 1/2 inch by 1/2 inch aluminum grid.
 2. Aluminum border if required.
 3. Provide frame for appropriate ceiling mounting.
 4. Baked white enamel finish or powder paint white finish.
- E. Heavy Duty Wall Return Air Grille (for use in gymnasiums)
1. Heavy gauge steel construction specifically designed for gym use.
 2. Angled louvers spaced 1/2 inch on center.
 3. Baked aluminum enamel or powder paint aluminum finish.
- F. Supply Air Linear Slot Diffusers
1. 22 gauge, aluminum or heavy gauge steel diffusers assembly with factory baked white enamel finish or powder paint white finish.
 2. 26 gauge, zinc-coated steel inlet boot, maximum 16 inches high (3 slot).
 3. The pattern controller shall be an aerodynamically curved “ice-tong” shaped steel deflector capable of 180° pattern adjustment from the face of the diffuser and shall allow dampering if required.
 4. 1/2 inch glass fiber acoustically insulated inlet plenum/boot.
- G. High Capacity Drum Louvers
1. All heavy gauge aluminum split vane construction.
 2. Minimum 25° rotation from centerline of diffuser.
 3. Heavy extruded aluminum blades shall be individually adjustable.
 4. Baked white enamel finish or powder paint white finish.

5. Opposed blade volume damper for all drum louvers constructed of heavy gauge steel – Damper must be operable from the face of the grille.
- H. Return Air Linear Slot grilles
 1. Shall be constructed the same as Supply Air Linear Slot Diffusers without the pattern controllers.

PART 3-EXECUTION

3.1 INSTALLATION

- A. The contractor shall be held responsible for the location, size and placing of all openings for grilles, registers and outlets. The contractor shall consult with the Architect before the walls are built and the grounds placed. All outlets, registers and grilles with exposed screw fastener, shall be fastened with Phillips type oval head screws.
- B. Install in accordance with manufacturer's instructions.
- C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting.
- D. Install diffusers to ductwork with airtight connection.
- E. Provide balancing dampers on duct take-off to diffusers, grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black.

3.2 SCHEDULES

- A. Size and type as shown on drawings.

END OF SECTION 233713

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Rooftop exhaust ventilators.
- B. Rooftop intake ventilators

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Submittals are required and shall include materials, sizes, quantities, and dimensions.

1.3 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Greenheck
- B. Cook
- C. Penn Barry

2.2 COMPONENTS

- A. Louvered Penthouse Units
 - 1. Shall be constructed of heavy gauge aluminum.
 - 2. Support members shall be constructed of galvanized steel.
 - 3. Hood shall be removable from base or hinged.
 - 4. Shall include ½ inch galvanized steel bird screens.
 - 5. Underside of hood shall be insulated to reduce condensation.
 - 6. Exterior finish shall be factory aluminum finish.
 - 7. Unit manufacturer to provide a motor operated damper in unit throat.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Provide the number and type of ventilators as required.
- B. Mount units on roof curbs. Roof curbs to be furnished and set by Mechanical Contractor. Cutting of opening is by Mechanical Contractor. Flashing is by the General Contractor.

END OF SECTION 233723

SECTION 233725 - EXTERIOR WALL LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Extruded aluminum, wind driven rain resistant, stationary louver with horizontally mounted sight proof blades.
- B. Brick vents.

1.3 SUBMITTALS

- A. Submit shop drawings indicating materials, construction, dimensions, accessories, and installation details.
- B. Coordinate with Section 08 91 19.

1.4 QUALITY ASSURANCE

- A. AMCA Standard 511.

1.5 WARRANTY

- A. Manufacturer shall provide standard limited warranty for louver systems for a period of one year from date of installation, no more than 18 months after shipment from manufacturing plant. When notified in writing from the Owner of a manufacturing defect, manufacturer shall promptly correct deficiencies without cost to the Owner.

PART 2- PRODUCT

2.1 MANUFACTURERS

- A. Ruskin Model EME 420 DD
- B. AIROLITE SCH201
- C. Construction Specialties
- D. American Warning

2.2 COMPONENTS

- A. Wind Driven Water Penetration Performance:
 - 1. Frame shall be 4" deep, 6063T6 extruded aluminum with .081 nominal wall thickness.

2. Blades shall be 6063T6 extruded aluminum .063" nominal wall thickness. Double drainable blades are sight proof.
 3. Screen shall be 5/8 x .040" expanded flattened aluminum bird screen in removable frame. Screen adds approximately 1/2" to louver depth.
 4. Based on testing 39 inches x 39 inches (1 m x 1 m) core area, 41 inches x 44 inches (1.04 m x 1.12 m) nominal size unit in accordance with AMCA 500-L.
 5. Wind Velocity: 29 mph.
 - a. Rainfall Rate: 3 inches/hour.
 - b. Free Area Velocity: 1190 feet per minute.
 - c. Water Resistance Effectiveness: 99.% (AMCA Class A).
 6. Wind Velocity: 50 mph.
 - a. Rainfall Rate: 8 inches/hour.
 - b. Free Area Velocity: 759 feet per minute.
 - c. Water Resistance Effectiveness: 99.3% (AMCA Class A).
 7. Finish shall be factory applied baked enamel. Color and finish shall be selected by architect from manufacturers standard selections.
- B. Cast Aluminum Brick Vents
1. Ruskin Model BVC100-356 cast aluminum brick vent, 4" deep. Size as scheduled.
 2. 7x7 mesh aluminum insect screen.
 3. Equals by AIROLITE, Construction Specialties, or American Warming.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Louvers and screens to be furnished by the Mechanical Contractor and installed by the General Contractor.

END OF SECTION 233725

SECTION 233726 - ROOF CURBS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Roof curbs for equipment mounting.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specifications.
- B. Shop drawing shall include material, quantities, and dimensions.

1.3 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Pate
- B. Thy Curb.
- C. RPS Systems

2.2 COMPONENTS

- A. Roof Curbs
 - 1. Minimum height shall be 24".
 - 2. Roof curb shall be constructed of galvanized steel with welded corner beads and pressure treated 2 by 2 wood nailer.
 - 3. Curbs shall be pre-insulated with 1-1/2 inch rigid insulation.
 - 4. Top of curb shall be set dead level.
 - 5. Base of curb shall match roof slope.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Roof curbs and equipment rails shall be mounted with top dead level, properly anchored to the deck.
- B. All roof curbs shall be furnished and set by mechanical contractor. Cutting of opening is by

Mechanical Contractor. Flashing is by the General Contractor.

END OF SECTION 233726

SECTION 235100 - BREECHING, CHIMNEYS, AND STACKS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Venting for fuel burning equipment.

1.2 SUBMITTALS

- A. Submit shop drawing and product data per applicable Division I Specifications
- B. Shop drawings shall include product data noting materials, sizes, and dimensions. Detailed shop drawings denoting layouts, specific to project for each vent is required.

1.3 QUALITY ASSURANCE

- A. Products and installation shall be in accordance with NFPA 211 and UL listed.
- B. Each vent section/fitting shall be labeled for UL compliance.
- C. Installation shall be in conformance with OBC.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURES

- A. Selkirk Commercial
- B. Metalfab
- C. Heat-Fab
- D. DuraVent

2.2 COMPONENTS FOR LISTED SPECIAL GAS VENTS (LSGV's)

- A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, for Category II and IV appliances, suitable for use with properly rated and manifolded appliances. complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.
- C. Inner Shell: ASTM A 959, Type AL29-4C stainless steel.
- D. Outer Jacket: Stainless steel.
- E. Inner Pipe Size: See drawings for inner pipe size.

- F. Accessories: Angled inlet tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
- G. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
- H. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
- I. Termination: Exit cone with drain section incorporated into riser.

2.3 COMPONENTS- TYPE B GAS VENTS

- A. Round double wall, with aluminized steel inner pipe galvanized steel outer pipe.
- B. Furnished with manufacturer's fittings.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54 (ANSI Z223.1).
- C. Install with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Pitch with positive slope up from fuel-fired equipment to chimney or stack.
- E. For all gas vents, maintain UL listed minimum clearances from combustibles. Assemble pipe and accessories as required for complete installation.
- F. Level and plumb chimney and stacks.
- G. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- H. At appliances, provide slip joints.
- I. Each flue shall be supported from the building structure, not from or on the equipment.
- J. All roof flashing shall be the responsibility of the General Contractor.

3.2 SCHEDULES

EQUIPMENT

Boiler
Water Heaters

VENT SYSTEM

Refer to boiler specification section
Type B

END OF SECTION 235100

SECTION 235222 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Condensing, Modulating Boilers

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Product data and/or drawings shall be submitted to the engineer for approval and shall consist of:
 - 1. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, efficiency curves, etc.
 - 2. Schematic flow diagram of gas valve trains.
 - 3. Schematic wiring diagram of boiler control system that shows all components, interlocks, etc and shall clearly identify factory wiring and field wiring.
 - 4. Pressure Drop Curve. Submit pressure drop curve the following flow ranges per designated capacities below.
 - a. 2500 MBH: 0-400 GPM
 - c. If submitted material is different from that of the design basis, boiler manufacture shall incur all costs associated with reselection of necessary pumps. Possible differences include, but are not limited to, the pump type, pump pad size, electrical characteristics and piping changes.
- C. Full Function Factory Fire Test must be performed and documented on fire test label on boiler.
- D. Operation and Maintenance Manuals shall be submitted prior to final acceptance by the engineer and shall contain shop drawings, product data, operating instructions, leaning procedures, replacement parts list, maintenance and repair data, etc.

1.3 QUALITY ASSURANCE

- A. Unit shall be constructed in accordance with ASME Boiler and Pressure Vessel Code Section VIII.
- B. IBR compliance.
- C. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification, shall perform as specified and shall be the manufacturer's standard commercial product unless specified otherwise.

- D. Electrically operated components specified are to be “Listed” and/or “Labeled” as defined by NFPA 70, Article 100.
- E. Boilers shall bear an ASME “H” stamp.
- F. Boiler shall be CSA certified.
- G. Boiler shall be AHRI listed and certified.

1.4 WARRANTY

- A. The boiler manufacturer shall warrant each boiler, including boiler, trim, boiler control system, and all related components, accessories, and appurtenances against defects in workmanship and material for a period of twelve (12) months from date of startup (Not to exceed 18 months from date of shipment). Heat exchanger and fuel burner shall be warranted for a period of ten (10) years from date of shipment.

1.5 COORDINATION

- A. Equipment shall be handled, stored and installed in accordance with the manufacturer’s instructions.

1.6 CERTIFICATION

- A. Manufacturer’s Certification. The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
 - 3. Each Boiler shall be ASME compliant.
 - 4. Each boiler shall be CSA certified for at least 92% efficiency based on operating conditions specified for testing under ANSI Z21.13/CSA 4.9.
 - 5. Each boiler shall be CSD-1 compliant.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Aerco – Benchmark (Basis of Design)
- B. Cleaver Brooks - Clearfire
- C. Camus – Advantus
- D. Patterson Kelley – Storm

2.2 GENERAL

- A. The boiler plant consists of two (2) boilers with an input of 2,500 MBH with a gross output of 2,175 MBH. Each boiler shall be UL Listed, CSD-1 approved, ASME coded and stamped, and incorporate a gas train designed in accordance with FM or IRI. The boiler manufacturer must publish known part load value efficiencies; the thermal efficiency must increase as the firing rate decreases. Electrical service to each unit shall be 208V/3/60Hz, 20 amp service. The boiler control panel shall be proprietary in design and incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display, on individual field replaceable circuit boards mounted within a single housing. The boiler shall have an ASME approved relief valve setting of 50 psig.
- B. Construction:
 - 1. Boiler modules shall be natural gas fired, condensing fire tube design with a modulating forced draft power burner and positive pressure vent discharge.
- C. Main Gas Train
 - 1. Each boiler shall be provided with an integral main gas valve train. The main gas valve train(s) shall be factory assembled, piped, and wired. Each gas valve train shall include at least the following:
 - a. One (1) manual shutoff valve.
 - b. Two (2) safety solenoid valves. Valves equipped with dual solenoids that can be independently energized for leak testing and must be integrated into a single body design.
 - c. Air-Gas ratio control (maximum inlet pressure 14" W.C.).
 - d. One (1) low gas pressure switch (manual reset).
 - e. One (1) high gas pressure switch (manual reset) as required by code.
 - f. Two (2) pressure test ports.
 - 2. If gas pressure exceeds 14" W.C. the Contractor shall supply a suitable intermediate lockup type gas pressure regulator to reduce the pressure to acceptable levels. Mechanical contractor to extend regulator vent to the outdoors.
 - 3. The boiler manufacturer shall furnish each boiler with an integral power type fuel burner. The fuel burner shall be an assembly of a gas burner, combustion air blower, valve train, and ignition system. The burner manufacturer shall fully coordinate the burner as to the interaction of its elements with the boiler heat exchanger and the boiler control system in

order to provide the required capacities, efficiencies, and performance as specified.

4. Each burner shall be located near the top of combustion chamber with combustion gases flowing downward through the heat exchanger and constructed of stainless steel flange with perforated stainless steel inner backing plate and stainless steel outer knit.
5. Each boiler shall be equipped with direct spark ignition. Main flame shall be monitored and controlled by a flame rod (rectification) system.
6. Burner shall be capable of a 15:1 turndown.

D. Boiler safety and Trim Device

1. Boiler safety and trim devices shall be as follows:
 - a. Safety relief valve shall be provided in compliance with the ASME code.
 - b. Water pressure/temperature gauge.
 - c. Low Water/Flow cutoff.
 - d. Manual reset high limit water temperature controller.
 - e. Operating temperature control to control the sequential operation of the burner.
 - f. High and Low Gas Pressure switches as required.
 - g. Flame rod (rectification) system.

E. Heat Exchanger

1. Each hot water boiler shall consist of a stainless steel heat exchanger complete with trim, valve trains, burner, and boiler control system. The boiler manufacturer shall fully coordinate the boiler as to the interaction of its elements with the burner and the boiler control system in order to provide the required capacities, efficiencies, and performance as specified.
2. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2" or 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter.

3. Each boiler shall be capable of operating with a minimum outlet water temperature of 68°F.

F. Exhaust Manifold

1. The exhaust vent must be UL listed for use with category III or IV appliance operating temperatures of up to 480° F, positive pressures, condensing flue gas service. Currently, UL listed vents of Polypropylene and AL29-4C stainless steel. Proper clearance to combustibles must be maintained per UL and vent manufacturer. The exhaust manifold shall have a gravity drain for the elimination of the condensation with collecting reservoir. The first plant shall Terminate above roof with exit cone provided with vent package. The second plant shall terminate through the wall and above grade with a 45° discharge velocity cone.
2. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel with the following diameter flue connections:
 - a) BMK2500 – 8 inch

G. Direct vent installation:

1. All combustion air is drawn from the outdoors to the units via metal or PVC ducts, see manufacturers recommendations

H. Boiler Controls: Refer to Division 23, Section “Instrumentation and Control of HVAC.”

1. The boiler control system shall be segregated into three components: “Edge” Control Panel, Power Box and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.
2. The control panel shall consist of six individual circuit boards using state-of-the-art surface-mount technology in a single enclosure. These circuit boards shall include:
 - a. A display board incorporating LED display to indicate temperature and a vacuum fluorescent display module for all message enunciation
 - b. A CPU board housing all control functions
 - c. An electric low-water cutoff board with test and manual reset functions
 - d. A power supply board
 - e. An ignition /stepper board incorporating flame safeguard control
 - f. A connector board

Each board shall be individually field replaceable.

3. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.

4. The control panel hardware shall support both RS-232 and RS-485 remote communications.
5. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 34 separate fault messages.
6. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:
 - a. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
 - b. Setpoint Low Limit: Allow for a selectable minimum operating temperature.
 - c. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.
7. The boiler control system shall incorporate the following additional features for enhanced external system interface:
 - a. System start temperature feature
 - b. Pump delay timer
 - c. Auxiliary start delay timer
 - d. Auxiliary temperature sensor
 - e. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate
 - f. Remote interlock circuit
 - g. Delayed interlock circuit
 - h. Fault relay for remote fault alarm
8. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD 1.

9. Each boiler shall have an oxygen monitoring system that will measure the oxygen content of the exhaust gasses in real-time. Output of O₂ information shall be displayed on the C-More control panel.
10. Each boiler shall have integrated Boiler Sequencing Technology (BST), capable of multi-unit sequencing with lead-lag functionality and parallel operation. The system will incorporate the following capabilities:
 - a. Efficiently sequence 2-to-8 units on the same system to meet load requirement.
 - b. Integrated control and wiring for seamless installation of optional isolation valve. When valves are utilized, the system shall operate one motorized valve per unit as an element of load sequencing. Valves shall close with decreased load as units turn off, minimum of one must always stay open for recirculation.
 - c. Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize unit run hours.
 - d. Designated master control, used to display and adjust key system parameters.
 - e. Automatic bump-less transfer of master function to next unit on the chain in case of designated master unit failure; master/slave status should be shown on the individual unit displays.
 - f. Designated master control, used to display and adjust key system parameters.
11. For boiler plants greater than 8 units, the Boiler Manufacturer shall supply as part of the boiler package a completely integrated AERCO Control System (ACS) to control all operation and energy input of the multiple boiler heating plant. The ACS shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. One ACS controller shall have the ability to operate up to 32 AERCO boilers.

The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The ACS shall control the boiler outlet header temperature within +2°F. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The ACS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

The ACS shall have the following anti-cycling features:

- a. Manual designation of lead boiler and last boiler.
- b. Lead boiler rotation at user-specified time interval.
- c. Delay the firing/shutting down of boilers when header temperature within a predefined dead band.

When set on Internal Setpoint Mode, temperature control setpoint on the ACS shall be fully field adjustable from 50°F to 190°F in operation. When set on Indoor/Outdoor Reset Mode, the ACS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.

When set on MODBUS Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port. The ACS controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central ACS system and individual boilers shall be twisted pair low voltage wiring, with the boilers 'daisy-chained' for ease of installation.

MODBUS and BacNet protocols will be included with the Edge Controller to communicate with Building Management System.

I. ELECTRICAL POWER

1. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
2. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. All aspects of installation of Boiler Plant shall be in strict accordance with manufacturer's instructions. The vent system *must conform to* all manufacturer's recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure. The vent must be sized in accordance with manufacturers recommendations.
- B. Boiler plant piping shall be field constructed of materials as specified. Each boiler shall have individually isolating shutoff valves for service and maintenance. Each boiler shall

require a minimum gas pressure of 3" W.C. 4000 scfh (full load rated capacity). Each boiler shall be provided with an individual supply gas regulator for proper gas regulation with a 2" NPT connection. Mechanical contractor to extend regulator vent to the outdoors.

C. Field Services

1. Contractor shall provide the services of a local factory authorized representative to supervise all phases of equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the engineer with operation and maintenance instructions.

D. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundation specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration Controls for HVAC."
3. Manufacturer to provide removable casters to move boilers into place on units over 750 lbs.

E. Install gas-fired boilers according to NFPA 54, ANSI Z223.1 (United States)

F. Assemble and install boiler trim.

G. Install electrical devices furnished with boiler but not specified to be factory mounted.

H. Install control wiring to field mounted electrical devices.

I. Provide acid neutralizer tank for condensate line for each boiler. Acid neutralizer tank per manufacturers recommendations.

3.2 CONNECTIONS

A. Piping

1. Each boiler shall be provided with all necessary inlet and outlet connections. Refer to specific Boiler's specification sheet for connection sizes.
2. Check Manufacturer's Installation Manual for clearance dimensions and install piping that will allow for service and ease of maintenance.
3. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size.

B. Exhaust Venting

1. Install flue venting system per manufacturer's recommendations and state/provincial codes.

3.3 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for a total of four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 235222

SECTION 236200 - REFRIGERANT CONDENSING UNITS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Air-cooled, refrigerant condensing units with dual compressors.

1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. ASHRAE Standard 15.
- B. Certified performance to ARI 210/270/340.
- C. UL construction.
- D. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1

1.4 WARRANTY

- A. Compressors shall include an extended 5-year parts warranty.
- B. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Daiken
- B. Trane
- C. Johnson Controls Inc.
- D. Dunham Bush

2.2 COMPONENTS

- A. General – Units shall be assembled on heavy gauge steel mounting/lifting rails and shall be weather-proofed. Units shall include a hermetic scroll or reciprocating compressors, plate fin condenser coil, fans and motors, controls and holding charge of nitrogen. Operating range shall be between 115 and 35 degrees F in cooling mode as standard from the factory. Units shall be UL 1995 listed, certified and rated in accordance with ARI Standard 210/240, 340/360 or 365.

- B. Casing – unit casing shall be constructed of 18 gauge zinc coated heavy gauge galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a weather – resistant baked enamel finish. Unit surface shall be tested 500 hours in salt spray test. Units shall have removable end panels, which allow access to all major components and controls.
- C. Refrigeration System – Double Compressor – Units shall have two separate and independent refrigeration circuits. Each refrigeration circuit shall have an integral sub cooling circuit. A refrigeration filter drier shall be provided as standard. Units shall have both a liquid line and a suction gas line service valve with a gauge port.
- D. Condenser Coil – Coils shall be internally finned or smooth bore 3/8” copper tubes mechanically bonded to configured aluminum plate fin as standard. Factory pressure and leak tested to 420-psig-air pressure. A metal grille with PVC coating for coil protection is optional.
- E. Condenser Fan And Motor – Direct-drive, statically and dynamically balanced 26 or 28 inch propeller fan with aluminum blades and electro coated steel hubs shall be used in draw-through vertical discharge position. Either permanently lubricated totally enclosed or open construction motors shall be provided and shall have built in current and thermal overload protection. Motors shall be either ball or sleeve bearing type.
- F. Refrigerant: Compressors shall utilize R-410, 407R or R-134 A refrigerant.
- G. Provide all required safeties including over current thermal overload and single – phasing motor protection.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Startup and training to be provided by a factory-trained service technician for a total of four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- C. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 236200

SECTION 236426 – ROTARY SCREW WATER CHILLER

PART 1: GENERAL

- A. Air-cooled rotary screw packaged chillers.

1.2 REFERENCES

- A. Comply with applicable Standards/Codes of AHRI 550/590, ANSI/ASHRAE 15, ASHRAE 90.1 current version requirements, and ASME Section VIII.

1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with specification requirements.
- B. Submittals shall include the following:
 - 1. Dimensioned plan and elevation view drawings, required clearances, and location of all field connections,
 - 2. Single line schematic drawing of the field power hookup requirements, indicating all items that are furnished.
 - 3. Schematic diagram of control system indicating points for field connection and fully delineate field and factory wiring.
 - 4. Installation manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the codes and standards specified.
- B. Factory Tested: Packaged chiller shall be pressure tested, evacuated, and fully charged with refrigerant and oil, and be functionally run-tested at the factory.
- C. Factory trained and authorized service personnel shall perform pre-startup checks and startup procedures.

1.5 WARRANTY

- A. The chiller manufacturer's warranty shall cover parts and labor costs for the repair or replacement of defects in material or workmanship for a period of one year from equipment startup or 18 months from shipment, whichever occurs first
- B. Extended Compressor Warranty: 4 years extended compressor warranty, parts only.

PART 2: PRODUCTS

2.1 MANUFACTURERS

- A. Daiken
- B. Trane
- C. Johnson Controls Inc.
- D. Dunham Bush

2.2 UNIT DESCRIPTION

- A. Provide and install as shown on the plans, factory assembled, factory charged with R-134a, air-cooled, rotary-screw compressor packaged chillers in the quantity and size specified. Each chiller shall consist of multiple semi-hermetic screw compressors, direct-expansion evaporator, air-cooled condenser section, control system and all components necessary for protected and controlled unit operation.

2.3 DESIGN REQUIREMENTS

- A. General: Provide a complete rotary screw packaged chiller as specified and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.2.
- B. Performance: Refer to the schedule of performance on the drawings. The chiller shall be capable of stable operation to a minimum of 15 percent of full load without hot gas bypass. The unit shall have factory mounted, low ambient head pressure control providing operation to 32°F (0°C).
- C. Manufacturer must provide both sound power and sound pressure data in decibels. Sound pressure data per AHRI 370 must be provided in 8 octave band format at full load. In addition, A-weighted sound pressure at 30 feet should be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope. Sound power must be provided in 1/8 octave band format to highlight any tonal quality issues. If manufacturer cannot meet the noise levels (per the attached chart), sound attenuation devices and/or barrier walls must be installed to meet this performance level.

Sound Pressure (at 30 feet)																							
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA												
Sound Power																							
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dBA	75% Load dBA	50% Load dBA	25% Load dBA												
One-third Octave Band Sound Power																							
50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10 KHz

2.4 CHILLER COMPONENTS

- A. Compressor motors: Motors shall be high-torque, two-pole, semi-hermetic, squirrel-cage induction-type with inherent thermal protection on all three phases, and cooled by suction gas. The compressors shall be field serviceable, semi-hermetic, single-rotor screw type with one central helical rotor meshing with two opposing gate rotors. The gate rotor contact element shall be constructed of engineered composite material, dimensionally stable up to 1500°F and wear resistant for extended life. Compressors shall be vibration isolated from the frame by neoprene compression mounts and include an internal discharge compressor muffler. If a twin-screw design is used, the manufacturer shall provide an extended 5-year parts and labor warranty covering all additional moving parts. If compressor does not have an internal discharge compressor muffler, additional sound attenuation must be provided. Each compressor shall be equipped with a VFD providing compressor speed control as a function of the cooling load. Each VFD shall provide controlled motor acceleration and deceleration, and shall provide protection for the following conditions: electronic thermal overload, over/under current, stalled motor, input and output phase loss, high load current, and current unbalance. The VFD shall provide a minimum 95% compressor power factor at all load points. Compressors used in VFD controlled units must have electrically insulated, ceramic bearings to mitigate bearing and/or lubricant damage from stray electric current passage. Compressor shall be able to control compression ratio to optimize efficiency at all operating conditions. Units without this protection must have an extended 5-year compressor warranty.
- B. Evaporator: The evaporator shall be of the direct expansion type with single pass on the refrigerant and water side for high efficiency counterflow heat transfer and low pressure drops, carbon steel shell, and high efficiency finned copper tubes rolled into steel tube sheets. The evaporator shall be designed, inspected, and stamped in accordance with ASME Section VIII requirements. It shall be mounted and piped in the unit. The evaporator shall have ¾-inch thick closed-cell polyurethane insulation and an electric resistance immersion heater. This combination shall provide freeze protection down to -20°F ambient air temperature.
1. Flow Switch: The evaporator shall be equipped with a factory-mounted and wired flow switch.
 2. Evaporator shall have standard left-hand grooved connections when looking at the unit control panel.
- C. Coil shall be microchannel design and shall have a series of flat tubes containing multiple, parallel flow microchannels layered between the refrigerant manifolds. Tubes shall be 9153 aluminum alloy. Tubes made of 3102 alloy or other alloys of lower corrosion resistance shall not be accepted. Coils shall consist of a two-pass arrangement. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils shall withstand 1000+ hour acidified synthetic sea water fog (SWAAT) test (ASTM G85-02) at 120°F with 0% fin loss and develop no leaks.

1. Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct drive fan motors. Fan motors shall be weather protected, three-phase, direct-drive, TEAO, totally enclosed air-over motors with class F insulation or better. ODP motors are not acceptable. Each fan section shall be partitioned to avoid cross circulation. The fans shall be equipped with a heavy-gauge vinyl-coated fan guard. Condenser fans must be constructed of a single piece, molded composite material to provide low noise levels and protection against corrosion.
- D. Refrigerant Circuit: The unit must have refrigerant circuits completely independent of each other with one compressor per circuit; multiple per circuit shall not be acceptable. Each circuit shall include an electronic expansion valve, liquid line shut-off valve, replaceable core filter-drier, sight glass with moisture indicator, and combination discharge check and shutoff valve.
- E. Unit casing, structural members and rails shall be fabricated of painted steel, and shall be able to pass a 1000-hour salt spray test per ASTM B117. The control enclosure and unit panels shall be corrosion resistant painted before assembly. Unit shall have condenser coil grilles and base frame grilles.
- F. ELECTRICAL PANEL
 1. Control Panel: Single-point power connection to disconnect switch with through-the-door handle and with individual circuit breakers. A UL-approved weatherproof electrical panel shall contain the unit control system, control interlock terminals and field-power connection points. Box shall be designed in accordance with NEMA 3R rating. Hinged control panel access doors shall be tool-lockable. Barrier panels shall be provided to protect against accidental contact with line voltage when accessing the control system. Fan motors shall have inherent overload protection and compressor motors shall have three-phase motor overload protection. Factory-supplied power components shall include:
 - a. Individual contactors and circuit breakers for fan motors,
 - b. Circuit breakers and factory-mounted transformers for each control-circuit,
 - c. Unit power terminal blocks for connection to remote disconnect switch,
 - d. Terminals for power supply to the evaporator heater circuit.
 - e. Fan motors shall have inherent overload protection and compressor motors shall have three-phase motor overload protection.
 2. The control logic shall be designed to maximize operating efficiency and equipment life with protections for operation under unusual conditions and to

provide a history of operating conditions. The system shall intelligently stage the unit to sustain leaving water temperature precision and stability while minimizing compressor cycling.

3. Equipment protection functions controlled by the microprocessor shall include high discharge pressure, loss of refrigerant, loss of water flow, freeze protection, and low refrigerant pressure. User controls shall include:
 - a. auto/stop switch,
 - b. chilled water set-point adjustment,
 - c. anti-recycle timer,
 - d. digital display with water temperature and setpoint,
 - e. operating temperatures and pressures, and diagnostic messages.
4. The following features and functions shall be included:
 - a. Durable liquid crystal display (LCD) screen type, having minimum four 20-character lines with 6 key input pad conveniently mounted on the unit controller. Default language and units of measure shall be English and I-P respectively. Messages shall be in plain English. Coded messages, LED indicators and LED displays are not acceptable.
 - b. Separate control section and password protection for critical parameters.
 - c. Remote reset of chilled water temperature using a 4-20mA signal
 - d. Soft-load operation, protecting the compressor by preventing full-load operation during the initial chilled fluid pull-down period
 - e. BAS communication flexibility through modular plug-in BACnet® with MSTP
 - f. Non-volatile program memory allowing auto-restart after a power failure.
 - g. Recording of safety shutdowns, including date-and-time stamp, system temperatures and pressures. A minimum of six previous occurrences shall be maintained in a revolving memory
 - h. Start-to-start and stop-to-start cycle timers, providing minimum compressor off time while maximizing motor protection
 - i. Lead-lag compressor staging for part-load operation by manual selection or automatically by circuit run hours

- j. Discharge pressure control through intelligent cycling of condenser fans to maximize efficiency
- k. Pro-active compressor unloading when selected operating parameters exceed design settings, such as high discharge pressure or low evaporator pressure
- l. Diagnostic monitoring of unit operation, providing a pre-alarm signal in advance of a potential shutdown, allowing time for corrective action

PART 3: EXECUTION

3.1 INSTALLATION

- A. Install in strict accordance with manufacturer's requirements, submittal drawings, and contract documents.
- B. Measures must be taken to avoid accumulation of debris in the evaporator during initial system flushing. A strainer with perforation no larger than 0.125" diameter must be placed in the supply water line just prior to the inlet of the evaporator. Care shall be exercised when welding pipe or flanges to the evaporator to prevent any slag from entering the vessel. Any welds after the strainer must be mechanically cleaned to avoid slag entering the evaporator.
- C. Adjust and level chiller in alignment on supports.
- D. Coordinate electrical installation with electrical contractor.
- E. Coordinate controls with control contractor.
- F. Provide all required accessories or accompanying parts to insure a fully operational and functional chiller.

3.2 START-UP

- A. Startup and training to be provided by a factory-trained service technician for a total of four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 236426

SECTION 237200 - AIR TO AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Total energy recovery wheels.
- B. See section 23 73 13 for matching modular air handling unit.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. Total energy heat wheel recovery performance shall be in accordance with ASHRAE Standard 84.
- B. Compliance to ARI 1060.
- C. Units shall bear the ETL label and shall be ETL certified.
- D. Wheel performance at specified conditions shall be guaranteed by the manufacturer.

1.4 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS APPROVED STANDARD OFFERING

- A. Daiken
- B. Trane
- C. Johnson Controls, Inc.
- D. Dunham Bush

2.2 COMPONENTS

- A. The total energy heat recovery wheel shall reclaim both sensible and latent heat at minimum efficiency as listed in schedules.
- B. The unit shall be constructed of structural steel tubular frame with epoxy primer and finish. The cabinet shall be 16 gauge bright galvanized steel construction.

- C. Wheel Media: The ECW or enthalpy wheel shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated, bonded, or synthesized onto the media are not acceptable due to delamination or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for air flow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by air flow are unacceptable due to the possibility of channeling and performance degradation. The minimum acceptable performance shall be as specified in the drawings/submittal.
- D. The face velocity across each side of the media (supply and exhaust) shall be less than 800 FPM and more than 350 FPM with a purge method that prevents exhaust air from being recirculated.
- E. Each unit shall include a frost control method per sequence of operation specification. The control for the unit shall be provided through the building DDC control system.
- F. Furnish a digital display for read out of both air stream temperatures and control settings.
- G. Provide filter racks and minimum MERV rating of 8 on both entering air sides to the wheel.
- H. Unit Construction: The energy wheel section shall contain the wheel and all upstream and downstream access requirements for airflow and maintenance. Casing shall be of G90 double wall construction. Opposing air-streams shall be separated by an insulated double wall panel. Adequate length must be provided in the section for bearing and wheel maintenance. Wheel cassette must be able to slide out of unit for servicing without disassembling air handling unit.
- I. The energy recovery wheel shall be coated with desiccant without the use of binders or adhesives, which may plug the desiccant aperture. The substrate shall be lightweight polymer and shall not require additional coatings for application in marine or coastal environments. Coated segments shall be cleanable; desiccant shall not dissolve or deliquesce in the presence of water or high humidity. Wheel bearings shall be selected to provide an L-10 life in excess of 30 years. Rim shall be continuous rolled stainless steel to form an even concentric rim.
- J. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The manufacturer in accordance with ASHRAE Standards 84 method of test and ARI Rating shall certify performance Standard 1060.
- K. Energy recovery section include a separate return air section and a separate bathroom exhaust fan section. The bathroom exhaust energy recovery section shall have an airflow monitoring station to maintain a fixed bathroom exhaust CFM. The bathroom exhaust

section shall be separate from the return air but shall pass through the energy recovery wheel for recovery. The return air shall be controlled to allow some of the air to pass through the energy wheel and some to pass back to the mixing box.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer shall test-check-start units.

END OF SECTION 237200

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SECTION 237313 - MODULAR INDOOR AIR HANDLING UNITS

Part 1 - GENERAL

1.1. SECTION INCLUDES

- A. Indoor Air Handling Units.

1.2. SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements. Computer generated fan curves for each air handling unit shall be submitted with specific design operating point noted. A computer generated psychometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted. Sound data for discharge, radiated and return positions shall be submitted by octave band for each unit. Calculations for required base rail heights to satisfy condensate trapping requirements of cooling coil shall be included.
- B. Product Data:
 - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, finishes of materials, electrical characteristics, and connection requirements.
 - 2. Provide data of filter media, filter performance data, filter assembly, and filter frames.
 - 3. Provide manufacturer's installation instructions.
 - 4. If submitted material is different from that of the design basis, Air Handler size, capacities, physical connections, electrical requirements, weight or concrete pad requirements, manufacture shall incur all costs associated with these required changes and coordination with other trades.

1.3. SAFETY AGENCY LISTED & CERTIFICATION

- A. Air Handling units shall be cETLus safety listed to conform with UL Standard 1995 and CAN/CSA Standard C22.2 No. 236. Air handler furnished with double width, double inlet (DWDI) fans and/or plenum fans where applicable, shall be certified in accordance with the central station air handling unit certification program, which is based on AHRI Standard 430. (NOTE: Above does not apply to fan array)
- B. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on AHRI Standard 410.

1.4. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept products on site on factory-furnished shipping skids. Inspect for damage.

- C. Store in clean dry place and protect from construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.5. WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

Part 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Daikin
- B. Johnson Controls, INC.
- C. Trane
- D. Dunham Bush

2.2. GENERAL DESCRIPTION

- A. Configuration: Fabricate as detailed on drawings.
- B. Performance: Conform to AHRI 430. See schedules on prints. (NOTE: above does not apply to fan array)
- C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

2.3. UNIT CONSTRUCTION

- A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
- B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
 - 1. The inner liner shall be constructed of G90 galvanized steel.
 - 2. The outer panel shall be constructed of G90 galvanized steel.
 - 3. The floor plate shall be constructed as specified for the inner liner.
 - 4. Unit will be furnished with solid inner liners.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.

- D. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5" w.c. in positive pressure sections and -6" w.c. in negative pressure sections (.0025 m³/s per square meter of cabinet area at 1.24 kPa static pressure)
- E. The casing leakage rate shall not exceed 1% of supply air volume at design static pressure up to a maximum of +8" w.c. in positive pressure sections and -8" w.c. (1.99 kPa) in negative pressure sections.
- F. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
- G. Access doors shall be flush mounted to cabinetry, with minimum of two, six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- H. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping. The base rail shall be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. An 8-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping.
- I. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2" thickness of insulation under drain pan.
- J. Factory leakage test available for units selected with high pressure, low leakage construction. The unit manufacturer shall provide a witnessed factory leak test on selected units. The cabinet shall be tested at the unit's positive and negative maximum design operating static pressure, up to 8" of differential static pressure across the cabinet exterior walls for the entire unit. Cabinet leakage shall not exceed Class 6 leakage per ASHRAE Standard 111. All supply and return opening shall be sealed. Air pressure and flow shall be measured by a third party calibrated and certified apparatus. The testing shall be performed at the factory. Owner's representative shall select on unit to be tested at the time of order. A written test report shall be prepared by the manufacturer and issued to the owner's representative.
- K. Factory panel deflection testing available for units selected with high pressure, low leakage construction. The unit manufacturer shall provide a factory deflection test on one unit at the unit's positive and negative maximum design operating static pressure, up to 8" of differential static pressure across the cabinet exterior walls for the entire unit. A deflection limit of L/240 will be demonstrated at this time. "L" is defined as the height of a panel on the side of the unit. Measurement shall be at the mid-point of "L" along the largest panel on one side. Owner's representative shall select on unit to be tested at the time of order. A written test report shall be prepared by the manufacturer and issued to the owner's representative.

2.4. FAN ASSEMBLIES

- A. Acceptable fan assembly shall be a single width, single inlet, class II, direct-drive type plenum

fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes. Provide access to motor and fan assembly through hinged access door. Provide number of fans for air handler as shown on drawings.

1. Unit shall have two 9 blade direct drive class II fans.
 2. Manual block-off mounted upstream of fan for isolation of individual fans.
 3. Single source power motor control panel with short circuit protection factory wired from panel to motors in conduit shall be provided.
 4. Fan shall include peizo ring per fan for air flow monitoring. Transducer shall be included.
- B. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.

2.5. BEARINGS, SHAFTS, AND DRIVES

- A. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be provided on the motor with the fan wheel mounted directly on the motor shaft, AMCA arrangement 4.
- B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
- C. The fan wheel shall be direct coupled to the motor shaft. The wheel width shall be determined by motor speed and fan performance characteristics.

2.6. ELECTRICAL

- A. Fan motors shall be manufacturer provided and installed, VFD rated, Open Drip Proof, premium efficiency (meets or exceeds EPAct requirements), single speed, 460V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
- B. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
- C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
- D. Air handler manufacturer shall provide, variable speed drive with electrical characteristics for field installation by EC such as indicated on project schedule and shown on manufacturer's data sheets.

2.7. COOLING AND HEATING COILS

- A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions

will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.

- B. Water cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
 2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
 3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
 4. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
 5. Coil casing shall be a formed channel frame of galvanized steel.
- C. Water heating coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
 2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube

for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.

3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
4. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
5. Coil shall be furnished as an uncased galvanized steel track to allow for thermal movement and slide into a pitched track for fluid drainage.

2.8. FILTERS

- A. Furnish flat panel filter section with 2-inch or 4" pleated MERV 8 filter. Provide side loading and removal of filters.
- B. Furnish combination filter section with 2-inch or 4" pleated MERV 8 flat pre-filter and 12-inch Varicel SH cartridge, 95% efficient (MERV 13) final filter. Provide side loading and removal of filters.
- C. Filter media shall be UL 900 listed, Class I or Class II.
- D. Filter Magnehelic gauge(s) shall be furnished and mounted by equipment manufacturer and wired back to the Building Management System.

2.9. ADDITIONAL SECTIONS

- A. Plenum section shall be provided and properly sized for inlet and/or discharge air flow (between 600 and 1500 feet per minute). The plenum shall provide single or multiple openings as shown on drawings and project schedule.
- B. Access section shall be provided for access between components.
- C. Mixing box section shall be provided with end outside air opening and no return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Connecting linkage and ABS plastic end caps shall be provided when return and outside air dampers are each sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.
- D. Economizer section shall be provided with end outside air opening and top return air opening and top exhaust air opening without (opening only) or with parallel low leak airfoil damper blades. If furnished with dampers, they shall be hollow core galvanized steel airfoil blades, fully gasketed

and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow. Return and outside air dampers of different sizes or very large dampers and exhaust dampers must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

- E. Energy recovery wheel requirements shall be based on air-to-air energy recovery specification 237200.
- F. Unit shall include outside air flow monitoring.
- G. Provide filter racks and minimum MERV rating of 7 on both entering air slides to the heat wheel
- H. Each heat wheel shall include a frost control method. The control for the unit shall be provided through the building DDC control system.
- I. Lighting and Convenience outlet circuit
- J. Vapor-proof service light and convince outlet shall be provided in each fan section and mixing box section.

Part 3 - EXECUTION

3.1. INSTALLATION

- A. Install in accordance with manufacturer's Installation & Maintenance instructions.
- B. Startup and training to be provided by a factory-trained service technician for a total of four (4) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- C. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

3.2. ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test ran under observation.

3.3. EXTRA MATERIALS

- A. Provide one complete set of filters and belts for each air handling unit, for owners use at completion of project.

END OF SECTION 237313

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SECTION 238123 - COMPUTER ROOM AIR CONDITIONERS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Air conditioning unit intended specifically for computer rooms including package unit, refrigerant piping and specialties, humidifier, reheat control, valves, and unit controls.

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting capacity, materials, controls, dimensions, and accessories.

1.3 QUALITY ASSURANCE

- A. Refrigeration system shall meet ASHRAE 15.
- B. Energy-efficiency ratio shall meet ASHRAE 90.1.
- B. Performance rating shall comply with ARI 310/380.
- C. All three phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built in protection, or by protection built into a variable frequency drive.

1.4 WARRANTY

- A. The entire unit shall be warranted for 5 years.
- B. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Liebert
- B. APC – Stulz
- C. United CoolAir
- D. Data-Aire

2.2 GENERAL

- A. Summary

1. These specifications describe requirements for an environmental control system. The system shall be designed to control temperature and relative humidity conditions within a room. The manufacturer shall design and furnish all equipment in the quantities and configurations shown on project drawings. System shall be supplied with ETL and CSA (NRTL) listing according to UL 1995. See schedule for size and capacity.

B. Design Requirements

1. The environmental control system shall be a Liebert Mini Mate2 factory assembled unit. On direct expansion models, the refrigeration system shall be split, with the compressor located in a remote or close-coupled condensing unit. Contractor shall note on drawings the distance the remote condensing unit is located from the indoor unit. Any piping modifications required shall be accounted for in his bid.
2. The evaporator section shall be designed to be installed above dropped-ceiling installation. Condensing units shall be designed for outdoor installation.

C. Quality Assurance

1. The specified system shall be factory tested before shipment. Testing shall include, but shall not be limited to: Quality Control Checks, "Hipot" test (two times rated voltage plus 1000 volts, per NRTL agency requirements), and Metering Calibration Tests. The system shall be designed and manufactured to world class quality standards. The manufacturer shall be ISO 9001 certified.

2.3 PRODUCTS

A. Evaporator Cabinet Construction

1. The cabinet and chassis shall be constructed of heavy gage galvanized steel and shall be serviceable from one side only. Mounting brackets shall be factory attached to the cabinet.
2. Provide a minimum 2 inch, 2 pound density fiber insulation.

B. Air Distribution

1. The air distribution system shall be constructed with a quiet, direct-drive fan assembly equipped with double-inlet blower, self-aligning ball bearings, and lifetime lubrication. Fan motor shall be permanent-split capacitor, high efficiency type, equipped with two speeds for air flow modulation. Dehumidification shall utilize the lower fan speed.

C. Microprocessor Control

1. The control system shall be microprocessor based. The wall-mounted control enclosure shall include a 2- line by 16 character display.
2. LCD display providing continuous display of operating status and alarm condition. An 8-key membrane keypad for setpoint/program control, no/off, and fan speed shall be located below this display.

3. Temperature and humidity sensors shall be located in the wallbox which shall be capable of being located up to 300 ft. from the evaporator unit, via field supplied and wired thermostat type wire.

D. Monitoring

1. The LCD display shall provide an on/off indication, fan speed indication, operating mode indication (cooling, heating, humidifying, dehumidifying) and current day, time, temperature and humidity (if applicable) indication. The monitoring system shall be capable of relaying unit operating parameters and alarms to the Liebert Site scan monitoring system.

E. Direct Expansion Coil

1. The evaporator section shall include evaporator coil, thermostatic expansion valve, and filter dryer.
2. The evaporator coil shall have 3.1 sq. ft. face area, 3 rows deep. It shall be constructed of copper tubes and aluminum fins. The coil shall be provided with a stainless- steel drain pan. Refrigerant flow shall be controlled by an externally equalized thermostatic expansion valve.

F. Air-Cooled Prop Fan Condensing unit

1. The condenser coil shall be constructed of copper tubes and aluminum fins with a direct-drive propeller-type fan, and shall include a scroll compressor, high pressure switch, and lee-temp receiver. All components shall be factory assembled, charged with refrigerant, sealed, and be capable of being connected to the evaporator section using pre-charged refrigerant lines sets. No internal piping, brazing, dehydration, or charging shall be required. Condensing unit shall be designed for 95°F ambient and be capable of operation to -30°F.
2. A hot gas bypass circuit shall be provided to ensure operation under low load conditions.

G. Steam Generating Humidifier

1. The environmental control system shall be equipped with a steam generating humidifier that is controlled by the microprocessor control system. It shall be complete with disposable canister, all supply and drain valves, steam distributor, and electric controls. The need to change canister shall be annunciated on the microprocessor wallbox control panel. See schedule for size and capacity. An LED light on the humidifier assembly shall indicate cylinder full, over-current detection, full system fault, and end of cylinder life conditions.

H. Electric Reheat

1. The electric reheat shall be low-watt density, 304/304 stainless steel, finned-tubular and shall be capable of maintaining room dry bulb condition when the system is calling for dehumidification. The reheat section shall include a U.L. approved safety switch to protect the system from overheating.

I. Disconnect Switch, Non-Locking

1. The non-automatic, non-locking molded case circuit breaker shall be factory mounted in the high voltage section of the electrical panel. The switch shall be accessible for the front of the unit.

J. Air Distribution Plenum

1. The evaporator section shall be supplied with an air distribution plenum with integral filter. The plenum shall be 2'X4' in size and shall provide 4-way distribution, for installation into a standard 2'X4' ceiling grid. Filter size shall be 4", deep pleated type with minimum efficiency of 20%, based on ASHRAE 52-76.

K. Condensate Pump

1. The condensate pump shall have the minimum capacity of 30 GPH at 20 ft. head. It shall be complete with integral float switch, pump, motor assembly, and reservoir.

L. Refrigerant Line Sweat Adapter Kit

1. Provide a sweat adapter kit to permit field brazing or refrigerant line connections.

PART 3-EXECUTION

3.1 INSTALLATION

A. General

1. Install air conditioning unit in accordance with manufacturer's installation instructions. Install unit plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.

B. Electrical Wiring

1. Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

C. Piping Connections

1. Install and connect devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's piping connection diagram to plumbing contractor.

D. Supply and Drain Water Piping

1. Connect water supply and drains to air conditioning unit. Unit drain shall be trapped internally.

- E. Startup and training to be provided by a factory-trained service technician.
- F. Contractor shall verify the length of refrigerant piping and make any allowances for larger piping if required.

3.2 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for a total of two (2) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 238123

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SECTION 238126 - DUCTLESS SPLIT SYSTEM

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. High wall mounted heating and cooling split systems.
- B. Ceiling suspended 4-way throw heating and cooling split systems

1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes and dimensions.

1.3 WARRANTY

- A. Contractor shall warranty entire systems and equipment for a period of one (1) year.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Daikin AC
- B. Mitsubishi Electric
- C. Sanyo

2.2 COMPONENTS

- A. The aluminum supply air louvers are dual adjustable for air flow direction, to provide air flow throws to suit any installation. The louvers are mounted in an attractive high impact polystyrene front section. The unit will have Hi / Lo fan speeds with auto ramp operation that produce efficient, quiet operation, suitable for both residential and commercial applications.
- B. The model shall be equipped, as standard, with 24V control circuits to the outside unit.
- C. The energy efficiency shall be minimum as scheduled or as required by ASHRAE 90.1.
- D. Materials of Construction
 - Cabinet:
 - 1. Fabricated of 20 gauge galvanized steel.
 - 2. Powder coat finish.
 - 3. High impact polystyrene air discharge panel
 - 4. Intake grille -Removable, perforated steel inlet grille.

5. Discharge assembly -Adjustable, aluminum bi-directional louvers
 6. Condensate Drain Pan-Galvanized steel with anti-corrosion coating.
 7. Color -Cabinet matte finish, designer white.
 8. Discharge Vanes- aluminum.
- E. Air Systems
1. Fans are to be forward curve centrifugal type, directly mounted to the motor shafts and dynamically balanced.
 2. Motors: PSC type with internal thermal overload protection.
 3. Air Stream Surfaces are insulated with ¼” fiberglass and ½” foil face insulation.
 4. Filters: Washable, user accessible.
- F. Coil: Coil to be seamless, copper tubing, arranged in staggered configuration, with enhanced fins, tested to 460 psig. The tubes are mechanically expanded for secure binding to fin shoulder.
- G. Refrigerant Circuit- The units are equipped with Chatleff Piston expansion device. Connections are male flare type, diameters per table.
- H. Systems options
1. Provide a remote T stat for control and interface to BAS system.
 2. Trim kit
 3. Condensate pump with 4ft head.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install per manufacturer’s recommendations.

3.2 TRAINING

- A. Startup and training to be provided by a factory-trained service technician for a total of two (2) hours. These hours of training are to be "bankable hours" used within one full warranty year.
- B. All training and start-up shall be videotaped with a professional videographer and present two (2) copies of the training on DVD format to the Construction Manager within one (1) week of the training session. This DVD will be provided to the owner.

END OF SECTION 238126

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SECTION 238239 - UNIT HEATERS – PROPELLER

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Horizontal propeller unit heaters.

1.2 SUBMITTALS

- A. Submit shops drawings and product data per applicable Division I Specification
- B. Shop drawings shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. Capacity rated in accordance with ARI.
- B. Hydronic coils shall be pressure tested to 400 psig.
- C. Units shall be UL or ETI listed and labeled.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Sterling
- B. Vulcan
- C. Trane
- D. Daikin

2.2 COMPONENTS

- A Hydronic Propeller Unit Heaters
 - 1. Coils: Seamless copper tubing, .025 inch minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
 - 2. Casing: 18 gage steel with threaded pipe connections for hanger rods.
 - 3. Finish: Factory apply baked enamel on visible surfaces of enclosure or cabinet.
 - 4. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings.
 - 5. Air Outlet: Two- way adjustable louvers on horizontal throw models.

6. Motor: Horizontal models with permanently lubricated sleeve bearings.
7. Provide with: Local disconnect switch.
8. Capacity: Based on 65 °F entering air temperature, 180 °F entering water temperature, 30% propylene Glycol mixture, and a 30° F Delta T.

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION 238239

SECTION 238240 - CABINET UNIT HEATERS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Ceiling or wall mounted hydronic cabinet unit heaters as scheduled and located on drawings..

1.2 SUBMITTALS

- A. Submit shop drawings and product data per applicable Division I Specification.
- B. Shop drawings shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. Capacity rated in accordance with ARI.
- B. Hydronic coils shall be pressure tested to 400 psig.
- C. Units shall be UL or ETI listed and labeled.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Sterling
- B. Trane
- C. Vulcan
- D. Daikin

2.2 COMPONENTS

- A Hydronic Cabinet Unit Heaters
 - 1. Cabinets shall be 16 gage formed steel suitable for Semi or recessed ceiling mounting or wall mounting. Provide with stamped grilles for air inlet and outlet.
 - 2. Provide with end pockets on both ends of the cabinet suitable in size for concealing piping and valving.
 - 3. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 22 degrees.
 - 4. Cabinet: 16 gage steel with exposed corners and edges rounded, easily removed panels, and glass fiber insulation.

5. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, and direct driven.
6. Motor: Sleeve bearings, and resiliently mounted.
7. Provide with: Multiple speed switch, disconnect switch, and fused motor protection.
8. Filter: Easily removed one inch thick glass fiber throw-away type, located to filter air before coil.
9. Capacity: Based on 65° F entering air temperature, 180 °F entering water temperature, 30% Propylene Glycol mixture, and a 30° F Delta T.
10. Provided with a factory enamel finish

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION 238240

SECTION 238333 - ELECTRIC UNIT HEATERS

PART 1-GENERAL

1.1 SECTION INCLUDES

- A. Electric Unit Heaters

1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

PART 2-PRODUCTS

2.1 MANUFACTURERS

- A. Q-Mark
- B. Markel
- C. Berko

2.2 COMPONENTS

- A. Heavy gauge die formed steel housing.
- B. Completely enclosed fan motor.
- C. Fan delay feature eliminates cold drafts.
- D. Individually adjustable discharge louvers to control air flow.
- E. Aluminum-finned, copper clad steel sheath heating element has longer useful life, because of cooler sheath temperature and faster heat dissipation.
- F. Automatic reset linear thermal cut-out, capillary type, provides protection over entire length of element areas

PART 3-EXECUTION

3.1 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION 238333

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SECTION 260500-COMMON WORK RESULTS FOR ELECTRICAL**PART 1 - GENERAL****1.1 GENERAL AND EXECUTION**

- A. Related Documents:
 - 1. Drawings and general provisions of contract, including general and supplementary conditions, Division 0 and Division 1 specification sections, apply to the entire Division 26 documents.
- B. The intent of these specifications are for the contractor to provide all labor, material, supervision, and equipment necessary for a complete electrical installation as described in the drawings and specifications for a fully operative electrical system.
- C. The electrical installation of equipment and other work shall comply with or exceed all requirements of the latest edition of the National Electrical Code and all state and local codes and ordinances applicable to this project including the Ohio Building Code, latest edition.

1.2 SHOP DRAWINGS

- A. Contractor shall submit shop drawings and catalog cuts to architect.
- B. Shop drawings and catalog cuts that shall be submitted under this section include, but are not limited to the following:
 - 1. Motor starters and disconnects and motor control centers
 - 2. Distribution panelboards and switchboards
 - 3. Fuses
 - 4. Wiring devices
 - 5. Lighting Fixtures
 - 6. Fire Alarm System
 - 7. Transformers
- C. No portion of the work requiring submission of shop drawings, product data or samples shall be commenced until the submittals have been accepted by the owner. All such portions of the work shall be in accordance with accepted submittals.
- D. Acceptance of any material or product shall not relieve the contractor of his responsibility for meeting all the requirements of the specifications and shall not prevent subsequent rejections if such material or product is later found to be inferior.
- E. Electrical material and equipment furnished by the contractor shall be new, listed by Underwriters Laboratories and bear the "UL" label. Similar items shall be of the same manufacturer.

1.3 DISCREPANCIES, COORDINATION, GUARANTEES

- A. The contractor shall contact, prior to bid, the owner and architect in writing immediately if he notices any discrepancies or omissions in either the drawings or the specifications or if there are any questions regarding the meaning or intent thereof. No allowances shall be given to contractor after the work has begun.
- B. The contractor is required to visit the site and fully inform himself concerning dimensions, existing conditions and all other conditions affecting the scope of work. Failure to visit the site shall not relieve the contractor from any responsibility in the performance of his work.
- C. The contractor is responsible for coordinating the electrical installation. Costs generated due to poor coordination of work shall be paid by the contractor without cost to owner.
- D. The contractor shall guarantee all work installed under this contract to be free from defective workmanship and material, usual wear excepted. Should any defects develop within a period of one year after final acceptance by owner, the contractor shall replace the defective material and repair all defective workmanship and all resultant damage without cost to the owner.
- E. Before installing any of his work, this contractor shall see that it does not interfere with clearances required for finish on beams, columns, walls or other structural members shown on the drawings. The contractor shall make sure switches, controls, dimmers, and similar devices are installed on the lock side of door.

1.4 GENERAL INSTALLATION

- A. All scratches or chipped paint on electrical equipment are to be touched-up with matching paint. All dents in all electrical equipment are to be taken out and the prime or finish costs touched up. If damage is excessive, replacement will be required.
- B. After all equipment has been inspected and approved, thoroughly clean all equipment.
- C. Equipment mounted on either side of exterior block walls shall be mounted allowing a 3/4" (typical) space between wall and equipment.
- D. It is the responsibility of contractor to obtain detailed shop drawings of all equipment prior to rough in and making final connections.
- E. It is the contractor's responsibility to see that all equipment and apparatus that may require maintenance is made easily accessible. Although the location of the equipment may be shown on the drawings, the construction of the structure and the location of other equipment may not make its position easily accessible. Contractor is to call the attention of the owner to the condition before advancing the construction to a point where a change in the location would reflect additional cost.
- F. The contractor shall perform his own cutting and patching, trenching and backfill, excavation, core drilling, etc to install his work.

1.5 CODES

- A. The entire electrical installation shall be in compliance with or exceed the requirements of the latest edition of:
 - 1. The National Electrical Code, NFPA 70
 - 2. The National Fire Alarm Code, NFPA 72
 - 3. The National Electrical Safety Code
 - 4. OBC, and other State, county or local codes and ordinances having jurisdiction.
 - 5. The Institute of Electrical and Electronics Engineers, Inc., Publications.
 - 6. Underwriters Laboratories
 - 7. OSHA
- B. Conflicts between the above codes and the electrical drawings or specification shall be resolved as follows:
 - 1. Codes shall be considered as establishing minimum standards for methods, material and equipment.
 - 2. Where the electrical drawings or specifications exceed the requirements of the codes, then the electrical drawings or specification shall prevail.

1.6 CLEARANCES

- A. The contractor shall maintain minimum clearances for all electrical equipment such as panelboards, switchboards, starters, mcc's etc. as required by the National electrical Code, latest edition, regardless of where equipment is shown on drawing.

1.7 WATERPROOF SEALING OF CONDUITS

- A. Moisture sealant. Provide moisture seals for the exterior of conduits penetrating exterior or water bearing walls consisting of a cast-in-place water stop wall sleeve with a compressible rubber gasket between the conduit and the sleeve.
Provide seals for the interior of conduits which penetrate exterior or water bearing walls, consisting of gland type sealing bushings or closed cell silicone foam.

1.8 DEFINITIONS AND ABBREVIATIONS

- A. Definitions
 - 1. "Furnish" shall mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
 - 2. "Install" shall be used to describe operations at project site including unloading, packing, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning, and similar operations, as applicable in each instance.
 - 3. "Provide" shall mean furnish and install, complete and ready for intended use, as applicable in each instance.

4. "Directed" shall mean as directed by Owner prior to installation of equipment.
5. "Indicated" shall mean "indicated on Contract Drawings".
6. "Shown" shall mean "shown on Contract Drawings".
7. "Section" shall mean one of the Specification Sections.
8. "Division" shall mean one of the Specification Divisions.
9. "Article" shall mean one of the numbered paragraphs of the Specification Section.
10. "Work" or "Electrical Work" herein includes products, labor, equipment, tools, appliances, transportation and related items, directly or indirectly required to complete the specified and/or indicated electrical installation.
11. "Code" shall mean any regulations and requirements of regulatory bodies, public or private, having jurisdiction over the work involved.
12. "Product" used in Division 16 means material, equipment, machinery, and/or appliances directly or indirectly required to complete the specified and/or indicated Electrical Work.
13. "Standard Product" shall mean a manufactured product, illustrated and/or described in catalogs or brochures, which are in general distribution prior to the date of issue of construction documents for bidding. Products shall generally be identified by means of a specific catalog number and manufacturer's name.
14. "Wiring" shall mean fittings, conduits, wires, junction boxes, connections to equipment, splices, and other accessories required to complete the work.
15. Abbreviations and Symbols: See lists for both on drawings.
16. "Contractor" shall mean the contractor responsible for Division 16 work.
17. "Contract Documents" shall mean drawings, specifications, bid forms, addendum, and change orders.
18. Whenever the phrases "approved by the Professional or Owner," "approved equal," or "equal to" appear in these specifications, they shall be interpreted as meaning "as recommended by the Professional and approved by the Authority."
19. The word "Architect" or "Engineer" shall be interpreted as meaning "Project Professional."
20. The "Owner" shall mean the owner and operator of the Facility.

B. Reference to the following codes and standards shall mean:

<u>Reference</u>	<u>Definition</u>
NEC	National Electrical Code Current Edition
ASTM	American Society for Testing Materials
NEMA	National Electrical Manufacturers Association
ANSI	American National Standards Institute
FS	Federal Specification, U. S. Government
CS	Commercial Standards issued by U. S. Dept. of Commerce
NESC	National Electrical Safety Code
NETA	National Electrical Testing Association
ADA	Americans with Disabilities Act
EIA	Electronics Industries Association

1.9 SINGULAR NUMBER

- A. References made to any item in the singular number shall apply equally to as many identical items that the work may require.

1.10 ACCESSIBILITY

- A. Verify the adequacy of the size of shafts and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work. Pay particular attention to the ladder tray located above the dropped ceiling.
- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions.
- C. Locations of access doors in finished construction shall be submitted in sufficient time to be installed in the normal course of the work.

1.11 SLEEVES

- A. Provide and install sleeves where required to protect equipment or facilities in the installation. Each sleeve shall extend through its respective floor, wall or partition and shall be cut flush with each surface unless otherwise required.
- B. Sleeves in bearing and masonry walls, floors and partitions shall be standard weight steel pipe finished with smooth edges. For other than masonry partitions, through suspended ceilings, and for concealed vertical piping, sleeves shall be No. 22 U.S.G. galvanized iron.
- C. Sleeves shall be properly installed and securely cemented in place.
- D. Floor sleeves shall extend 1" above the finished floor, unless otherwise noted. Space between floor sleeves and passing conduit shall be caulked with graphite packing and waterproof caulking compound as approved.

- E. Where conduits pass through waterproofed floor or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves.
- F. Where conduits pass through roofs, sleeves shall be installed and flashed and made watertight by the contractor unless otherwise specified or shown on the drawings.
- G. Sleeves through exterior walls below grade shall have the space between conduit and sleeve caulked watertight, using an approved method.

1.12 ACCESS PANELS

- A. Furnish access panels not smaller than 12 " by 16" for access to concealed pull boxes, junction boxes or similar items where no other means of access is provided. The contractor shall install access panels.
- B. Access panels shall be all-steel construction with a No. 16 gauge wall or ceiling frame and a No. 14 gauge panel door with not less than 1/8" fireproofing secured to the inside of the door. Doors shall be provided with concealed hinges and cylinder lock except doors for wall panels which may be secured with suitable clips and countersunk screws. Outside of access panels shall finish flush with finished wall or ceiling surfaces. Covers shall be factory primed with two (2) coats of primer.

1.13 WIRE GAUGE

- A. The sizes of conductors and thickness of metals shown on the drawings or mentioned herein shall be understood to be American Wire Gauge.

1.14 ANCHOR BOLTS

- A. Provide and set in place, at the time of pouring of concrete foundations, necessary anchor bolts as required for the equipment called for under these specifications. Anchor bolts shall be of the hook type, of proper size and length to suit the equipment. Anchor bolts shall be set in pipe sleeves of approximately twice the

bolt diameter and one-half the embedded length of the bolt. Assume full responsibility for proper emplacement of the bolts.

1.15 GENERAL - EXECUTION

- A. Provide any chases or openings required under this Division. No cutting shall be done which may affect the building structurally or architecturally without the prior approval of the Professional. Damaged construction shall be restored to its original conditions and finished to match the surrounding work. Refer to Division 1, for additional cutting and patching requirements.
- B. Grades, elevations, and dimensions shown on the drawings are approximately correct; however, field check and otherwise verify such data at the site before proceeding with the work. Make necessary survey equipment available at all times and shall make use of

such equipment wherever necessary to properly install his equipment.

- C. The contractor shall be entirely responsible for apparatus, equipment, and appurtenances furnished by him or his sub-contractors in connection with the work and special care shall be taken to protect all parts thereof in such manner as may be necessary or as may be directed. Protection shall include covers, crating, sheds or other means to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment. Special care shall be taken to keep open ends of pipes closed while in storage and during installation. Where equipment must be stored outside the building, it shall be totally covered and secured with heavy weatherproofing tarps and kept dry at all times. Where equipment has been subjected to moisture, it shall be removed from the site and replaced with new equipment. Protect open excavating until covered over.
- D. Due to the schematic nature and small scale of the Electrical drawings, it is not possible to indicate exact locations, offsets, fittings, access panels, pull boxes, and miscellaneous parts which may be required to form a complete system. The drawings are generally indicative of the work to be installed. Arrange work accordingly, furnishing necessary parts and equipment as may be required to meet the various conditions and to provide a complete circuit from end use device to circuit protective device in panel. The contractor shall adjust the exact location of each drop within 5 feet of the area shown. The final location of the drop to be coordinated with the Owner.
- E. Within ten (10) days after notice to proceed, submit to the OWNER for approval, a complete list of equipment and materials to be furnished under this contract, giving names and addresses of manufacturers and material they intend to furnish. This source of supply shall be listed on forms available from the Professional.
- F. Take caution of routing conduit and location of equipment. In many cases, clearances in ceiling plenums is limited due to ductwork and other mechanical lines and systems and steel. This contractor is responsible for routing around mechanical equipment and ducts in order that everything can remain concealed in finished areas.
- G. Apply for detailed and specific information regarding the location of equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of failure to obtain this information shall be relocated and re-installed without additional expense to the Institution.
- H. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the Professional and Owner.
- I. Unless otherwise mentioned or indicated, mounting heights of outlets are shown on the drawings or in the specification. Dimensions given shall be considered to be from center of outlet to finished floor.
- J. Properly rough for the electrical conduit and equipment under this Division and modify as required for coordination during the construction period.

K. The location of electrical drops are shown on the drawings. The contractor shall assume that the drops may be moved, within 10 feet of the location shown. Coordinate exact location of each drop with the Owner.

L. Do not mount outlets back to back with through-the-wall boxes.

1.16 CONCRETE WORK AND EQUIPMENT BASES

A. Furnish all concrete work for all equipment bases, such as, panels, switchboards, transformers, switchgear, etc.

B. All floor mounted electrical equipment shall receive a concrete base.

C. The bases shall be 4" high and at least 4" larger around perimeter of the equipment or as shown. Increase pad sizes as required. All concrete pads and pole bases shall have 45 deg. 1" bevel at edges and shall be rubbed out.

D. All concrete to be reinforced, 4000 PSI.

1.17 EXCAVATION

A. Lay out all ditches and trenches to be excavated prior to digging. Review all other drawings for sewers, telephone, power, CATV, water, and gas. It is the responsibility of the electrical contractor to exercise caution whenever excavating for placement of conduit etc. The architect and engineer have tried to avoid any conflicts with other work but if electrical contractor damages any piping or equipment while he or his subcontractors are performing this work, he shall pay all costs to replace same and do it promptly, within 48 hours.

B. Slope sides of excavation to comply with local codes and ordinances. Shore and brace as required for stability of excavation.

C. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

D. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

E. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

F. Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

G. Locate and retain soil materials away from edge of excavations.

H. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

- I. Excavate trenches for electrical installations as follows:
 - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
 - 2. Excavate trenches to depth indicated or required.
 - 3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 - 4. Where rock is encountered, carry excavating below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
 - 5. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg. F.
 - 6. Place soil materials in layers to required subgrade elevations for each area.
 - 7. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 - 8. For raceways under roadways, provide 4-inch thick concrete base slab support. After installation of raceways, provide a concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 - 9. Backfill excavations as promptly as work permits, but not until completion of the following:
 - a. Inspection, testing, approval, and locations of underground utilities have been recorded.
 - b. Removal of concrete form work
 - c. Removal of shoring and bracing, and backfilling of voids.
 - d. Removal of trash and debris.
 - 10. Provide a yellow caution tape 18" above conduits when backfilling.
- J. Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. All ditches or cuts in work area to have 12 inches of premium fill along with all other requirements of the contract documents.
- K. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density of relative dry density for each area as required. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- L. Repair all underground excavation to original condition including walks, grass, drives, roadways, patios, etc.. Place backfill and fill materials evenly adjacent to structures,

pipng, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

1.18 TEMPORARY ELECTRIC

- A. The contractor shall be responsible for providing, maintaining and paying for the following temporary electrical requirements, except as otherwise noted.
- B. The contractor shall provide all labor and materials to provide temporary service for the construction areas.
- C. Furnish and install a temporary electric service for general use. Install service(s) large enough to serve the loads required during the construction phase.
- D. Electrical contractor is responsible for proper grounding installation.
- F. Electrical Service: comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70) and OSHA requirements. Include all equipment at service.
- G. Installation of temporary power and lighting system is to begin upon notification by the engineer and shall be installed and routed in a manner acceptable to the architect, local inspector and the utility company and the owner so as not to interfere with construction of the project.
- H. The main distribution panel shall have proper overcurrent protection in each panel and the enclosure if exposed to moisture shall be NEMA 3R. Provide GFI protection on all overcurrent devices.
- I. For power tools provide receptacles equipped with ground fault interrupters, reset button and pilot light for connections to power tools and equipment. Provide flexible power cords as required.
- J. Provide metal conduit, tubing or armored cable for protection of wiring where exposed to possible damage. No exposed wiring on floors, decks, etc.
- K. One electrician will be designated to maintain the temporary service. He shall be on site at all times when temporary electricity is required.
- L. Any trade requiring special electrical requirements beyond the capacity of the electrical service, shall provide and pay for such services.
- M. Exercise measures to conserve energy.
- N. Temporary lighting requirements are contained in OSHA safety and health standards, and expressed in terms of minimum intensities in foot candles.
- O. Furnish and install guard cages of tempered glass enclosure. Provide and install exterior type fixtures where exposed to moisture.

- P. Furnish and install at least one 20 ampere, 120 volt 1 phase grounding type receptacle (GFI) outlet for every 800 square feet of floor space. The maximum length of 20 ampere branch circuit shall not be over 200 feet from panelboard. Each outlet shall be on one overcurrent device.
- Q. The electrical contractor shall be responsible with all costs associated with the temporary electrical service.
- R. Installation Requirements:
 - 1. Completed portions of work shall not be used for temporary power.
 - 2. Provide solid grounding of the temporary service
 - 3. Ground the temporary branch circuits for power and lighting.

1.19 COMMISSIONING OF ELECTRICAL SYSTEMS

- A. The electrical contractor is responsible for all work outlined in specification section 'COMMISSIONING OF HVAC AND ELECTRICAL SYSTEMS' as defined in that section that relate to the Electrical Contractor.

END OF SECTION 260500

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SECTION 260501 – FIRE STOP**PART 1 – GENERAL****1.1 APPLICATIONS**

- A. Firestop systems for **Penetrations** in fire-resistance-rated assemblies, including both membrane and through penetrations.

AssembliesPenetration items:

Floors	Blanks
Roofs	Metallic Pipes
Walls and partitions	Non-Metallic Pipes
Smoke barriers	Cables
Floor/ceiling	Cable Trays
	Insulated Pipes
	Busways
	Duct and Vents
	Combinations

- B. Listed and labeled by a nationally recognized testing laboratory.
- C. Fire tested according to ASTM E814 (ANSI/UL1479)
- D. Flame Spread Index of < 25 and Smoke Developed Index of < 400 according to ASTM E84
- E. L-rating of < 20 CFM/Ft² for non-egress fire construction and < 5 CFM/Ft² for egress fire construction according to UL 1479 air leakage testing.
- F. W-Rating of Class I when tested in accordance with UL Water Leakage Test for systems tested and listed in accordance with ANSI/UL 1479.
- G. Volatile Organic Compounds (VOC) <1 according to ASTM E 595
- H. Firestop products shall not contain asbestos according to ASTM D 6620.

1.2 FIRESTOP SYSTEMS FOR CONSTRUCTION JOINTS/GAPS OCCURRING BETWEEN ASSEMBLIES:

- A. Type of assemblies:

Floor/Floor	Head of Wall (Top of Wall)
Floor/Wall	Edge of Slab (Curtain Wall)
Wall/Wall	Smoke Barriers
Bottom of Wall	

- B. Listed and Labeled by a nationally recognized testing laboratory.
- C. Fire tested according to ASTM E 1966 (UL 2079)

- D. Flame Spread Index of < 25 and Smoke Developed Index of < 400 according to ASTM E84.
- E. L-rating of < 20 CFM/Lnft for non-egress fire construction and < 5 CFM/Lnft for egress fire construction according to UL 2079 air leakage testing.
- F. Volatile Organic Compounds (VOC) <1 according to ASTM E 595
- G. Firestop systems designed to have Sound Transmission Coefficient (STC) of 40 minimum according to ASTM E 413.
- H. Firestop products shall not contain asbestos according to ASTM D 6620.

1.3 FIRE CONTAINMENT SYSTEMS FOR PROTECTION OF CRITICAL EQUIPMENT

A. Emergency Circuits Protection of:

Cables	Valves
Cable trays	Junction Boxes
Conduits	

- B. Products listed and labeled by a nationally recognized testing laboratory.

Types of systems:

Power cables
Control cables
Communication cables
Mechanical systems

- C. Fire tested according to ASTM E 1725 with fire exposure of either:
- 1. ASTM E119 (Standard fire exposure), or ASTM E1529 (Hydrocarbon fire exposure).
 - 2. Flame Spread Index of < 25 and Smoke Developed Index of < 400 according to ASTM E84.
 - 3. Volatile Organic Compounds (VOC) <1 according to ASTM E 595
 - 4. Products shall not contain asbestos according to ASTM D 6620.

1.4 REFERENCES AND QUALITY ASSURANCE

- A. American Society for Testing and Materials Standards (ASTM):
- 1. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E 814: Standard Test Methods for Fire Tests of Through-Penetration Firestops.
 - 3. ASTM E 119: Standard Test Methods for Fire Tests of Building Construction Materials.
 - 4. ASTM E 1725: Standard Test Methods for Fire Tests of Fire-Resistive Barrier Systems of Electrical Systems Components.

5. ASTM E 1966: Standard Test Method for Fire-Resistive Joint Systems.
 1. ASTM C 411: Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
- B. ASTM E 136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
- C. ASTM E 2307: Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate, Scale Multi-Story Apparatus
- D. Underwriters Laboratories, Inc. (UL):
1. UL 723 Standard for Test of Surface Burning Characteristics of Building Materials
 2. UL 1479 Standard for Fire Tests of Through-Penetration Firestops, including optional air leakage test.
 3. UL 2079 Standard for Tests for Fire Resistance of Building Joint Systems
 4. UL Water Leakage Test: W Rating – Class 1 (3 ft. water column for 72 hours)
- E. National Fire Protection Agency (NFPA)
1. NFPA 90A, 1999 Edition: Standard for the Installation of Air Conditioning and Ventilation Systems.
 2. NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
 3. NFPA 101: Life Safety Code
- F. Nationally Recognized Testing Laboratories:
1. Omega Point Laboratories (OPL)
 2. Southwest Research Institute (SwRI)
 3. Underwriters Laboratories Inc. (UL)
 4. Warnock Hersey (WH)
 5. Others as certified by the building code bodies.

1.5 DEFINITIONS

- A. **Firestop System:** The use of a specific firestop material or combination of materials in conjunction with a specific fire rated wall, floor, or ceiling construction type and a specific penetrating material(s) to achieve a rated fire barrier.
- B. **Assembly:** Particular arrangement of materials specific to a given type of construction described or defined in referenced documents.
- C. **Barrier:** Any bearing or non-bearing floor, wall, or ceiling assembly that has an hourly fire or smoke rating.
- D. **Firestopping:** Methods and materials applied in penetrations and unprotected openings to limit the spread of heat, fire, gasses and smoke.
- E. **Intumescent:** Materials that expand with heat to seal around objects threatened by fire.

- F. **Penetration:** Opening or foreign material passing through a floor, wall or ceiling barrier such that the full thickness of the rated material(s) is breached either in total or in-part.
- G. **Fire Resistive Joint:** Any joint or opening, whether static or dynamic, within or between adjacent sections of fire rated interior or exterior walls, floors, ceilings or roof decks.
- H. **Fireblocking:** Building materials installed to resist the free passage of flame, smoke and noxious gases to other areas of the building through concealed spaces.
- I. **Perimeter Fire Barrier System:** The perimeter joint protection that provides fire resistance to prevent the passage of fire from floor to floor within the building at the opening between the exterior wall assembly and the floor assembly.
- J. **Engineering Judgment:** Evaluations that are developed by a manufacturer for a new firestop system that complies with similar UL or Omega Point approved designs or tests that are acceptable to the code and enforced by the local jurisdictions. Reference E2032 for current definition
- K. **Water Leakage Test:** Introduced by Underwriters Laboratories on August 9, 2004 for systems tested and listed in accordance with ANSI/UL 1479.

1.6 PERFORMANCE REQUIREMENTS

- A. Penetrations: Provide through-penetration firestop systems that are installed to resist the spread of fire, passage of smoke and other hot gases according to requirements indicated, to restore the original fire-resistance rating of assembly penetrated.
- B. Install complete through penetration firestop systems that have been tested and are listed by recognized testing agencies per ASTM E 814 or UL 1479 fire tests in a configuration that is representative of site conditions.
- C. F-Rated Systems: Install through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814 or UL 1479, but not less than the fire resistance rating of the assembly being penetrated.
- D. T-Rated Systems: Install through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814 or UL 1479, where required by the Building Code.
- E. L-Rated Systems: Install through-penetration firestop systems with L-ratings as determined by UL 1479 and as required by the owner, architect or Authority Having Jurisdiction.
- F. W-Rated Systems: Install through-penetration firestop systems meeting W-Rating Class 1 Requirements as determined by the UL Water Leakage Test for systems tested and listed in accordance with UL 1479 and as required by the owner, architect or Authority Having Jurisdiction.

- G. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
- H. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- I. Fire Resistive Joints: Provide joint systems with fire resistance assembly ratings indicated, as determined by UL 2079 (ASTM E 1966), but not less than the fire resistance assembly rating of the construction in which the joint occurs. Firestopping assemblies must be capable of withstanding anticipated movements for the installed field conditions.
- J. For firestopping assemblies exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
- K. For floor penetrations exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
- L. Firestopping products shall have Flame Spread Index less than 25 and Smoke Developed Index less than 450, as determined per ASTM E 84.
- M. Where there is no specific third party tested and classified firestop system available for an installed condition, the firestopping contractor shall obtain from the firestopping material manufacturer an Engineering Judgment (EJ) to be submitted to the Approving Authority and Authority Having Jurisdiction for approval prior to installation. The EJ shall follow International Firestop Council (IFC) guidelines.

1.7 SUBMITTALS

- A. Submit in accordance with Section 01300, unless otherwise indicated.
- B. **Product Data:** Manufacturer's product literature and tested assembly for each type of fire protection material as follows:
 - 1. Product characteristics, typical uses, installation procedures, performance and limitation criteria.
 - 2. Material Safety Data Sheets (MSDS).
- C. **Shop Drawings:** For each fire protection system show construction conditions, relationships to adjoining construction, dimensions, description of materials and finishes, components, connections, anchorage methods, hardware and installation procedures, plus the following:
 - 1. Fire protection design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
 - 2. Documentation, including illustrations, from a qualified testing and inspection agency, that is applicable to each fire protection system configuration for construction.

- D. Where Project conditions require modification of a qualified testing and inspecting agency's illustration to suit a particular condition, submit Architect or Engineers illustration/digital pictures, with modifications marked and approved by fire protection system manufacturer's engineer.
- E. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article 1.7, to demonstrate their capabilities and experience, include a list of names and addresses of completed projects, architects, owners and other information specified.
- F. **Product Certificate of Conformance:** Signed by manufacturers of fire protection system products certifying that products furnished comply with requirements.
- G. **Assembly Listings:** Submit system assembly listings from a nationally recognized and accredited testing and inspection agency that is applicable to each firestop configuration.

1.8 QUALITY ASSURANCE

- A. **Installer's Qualifications:** Engage an experienced installer who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements, plus the following:
 - 1. Option 1 (3M Master Contractor)
In addition, installer/contractor must provide proof of current status as a "Certified 3M – Trained Master Contractor" having successfully completed the three day 3M Master Contractor training course.
 - 2. Option 2 (Certified 3M-Trained)
Installer/contractor must also provide proof of having successfully completed training conducted by 3M and being certified as having been 3M-Trained, or who is approved by Factory Mutual Research in accordance with Approval Standard FM 4991 – Approval of Firestop Contractors.
 - 3. Option 3 (Minimum Requirements)
- B. Acceptable to or licensed by manufacturer, state and local authority.
- C. Established record of successful in-service experience with fire protection systems and completion of manufacturer's certified product installation training with valid training card supplied by the manufacturer.
- D. **Source Limitations:** Obtain fire protection systems for each kind of construction application , from a single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fire protection products to Project site in original, unopened containers or packages, with intact and legible manufacturers' labels identifying product, manufacturer, date of manufacture, lot number, shelf life, qualified testing and inspection agency's classification marking, curing time and mixing instructions.

- B. Store and handle materials for fire protection products to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions. Stock rotation is recommended.

1.10 PROJECT CONDITIONS

- A. **Existing Conditions:** Verify the condition of the substrates and correct unsatisfactory conditions before installing products. Follow manufacturer's instructions.
- B. **Environmental Limitations:** Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation products.
- C. **Ventilation:** Ventilate during installation per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.
- D. **Protection:** Provide masking and drop cloths to prevent contamination of adjacent surfaces, if required.

1.11 COORDINATION

- A. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- B. Coordinate construction of openings and penetrating items to ensure that firestopping assemblies are installed according to specified requirements.
- C. Schedule firestopping after installation of penetrants but prior to concealing the openings.
- D. Do not conceal firestopping installations until the Owner's inspection agency or Authorities Having Jurisdiction have examined each installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. 3M
- B. HILTI
- C. STI

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which the fire protection material is to be installed and notify the architect of field conditions not conforming to tested assemblies causing schedule delays.

- B. Examine substrates to determine they are satisfactory to receive the fire protection materials.
- C. Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt or other foreign substances capable of impairing bond of fire protection materials.
- D. Verify penetrating items being protected, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
- E. Verify substrates are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with applying fire protection materials.
- F. Verify that environmental conditions are safe and suitable for installation of fire protection materials.
- G. Do not proceed with installation until the contractor in a manner acceptable to the architect has corrected unsatisfactory conditions.

3.2 PREPARATION

- A. Clean and repair substrates that could impair the adhesion or proper fitting of fire protection materials, including oil, grease, dust, rolling compounds, incompatible primers, and loose mill scale.
- B. Provide masking and temporary covering, as required, to prevent contamination of adjacent surfaces by fire protection materials.

3.3 INSTALLATION – GENERAL

- A. Installation of fire protection system shall be performed in strict accordance with the applicable listed system from a nationally accredited testing agency, manufacturer's detailed installation instructions and procedures.

3.4 INSTALLATION OF THROUGH-PENETRATION FIRESTOP SYSTEMS

- A. Install through-penetration firestop systems to comply with "Performance Requirements" Article 1.05 and firestop systems manufacturer's written installation instructions and published drawings for products and applications indicated. (See Article 3.04E "Through-penetration Firestop Systems Schedule")
- B. Install forming/damming/backing materials and other accessories of types required to support fill material during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop system.

- C. Install fill materials for firestop systems by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items as required to achieve the fire-resistance ratings indicated.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - a. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining surfaces.
- D. Watertight. Meets UL Water Leakage Test - Class 1 requirements for systems tested and listed in accordance with the criteria of ASTM E 814 (UL 1479) Standard Test Method for Fire Tests of Through-Penetration Fire Stops. W Rating - Class 1 requirements include a minimum water column exposure of 3 ft. for 72 hours prior to the standard time / temperature curve for the fire test.
- Through Penetration Sealants with a Fungicide. Sealants must meet the requirements of ASTM G 21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- E. Proceed with enclosing through-penetration firestop systems with other construction only after inspection and approval by Authority Having Jurisdiction.
- F. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
- G. Inspection Agency: If required, owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports indicating whether through-penetration firestop systems comply with or deviate from requirements.
- H. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
1. The words: "Warning: Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage"
 2. Contractor's name, address, and phone number
 3. Through-penetration firestop systems designation of applicable testing and inspecting agency
 4. Date of installation
 5. Through-penetration firestop system manufacturer's name
 6. Installer's name
- I. Clean off excess fill materials adjacent to openings as work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop systems manufacturer and that do not damage materials in which openings occur.
- J. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut

out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

3.5 INSTALLATION OF FIREBLOCKING SEALANT

- A. Shall comply with ASTM E-136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace of 750°C, current International Building Code (IBC), International Residential Code (IRC), International Residential Mechanical Code, International Fuel Gas Code, International Fire Code and NFPA 5000 draft, smoke and fireblocking requirements.
- B. Install fill materials for fireblocking applications by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items as required to achieve the seal required to meet the intent of fireblocking code requirements.
 - 2. Apply fill material so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing, finish to produce smooth, uniform surfaces that are flush with adjoining surfaces.
- C. Field Quality Control
 - 1. Proceed with enclosing fireblocking applications with other construction after inspection and approval by Authority Having Jurisdiction.
 - 2. Where deficiencies are found, repair or replace fireblocking applications so they comply with requirements.
 - 3. Inspection Agency: If required, owner will engage a qualified independent inspecting agency to inspect the fireblocking applications and to prepare test reports indicating whether fireblocking applications comply with or deviate from requirements.
- D. Identification
 - 1. Identify fireblocking applications with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each fireblocking application installation where labels will be visible to anyone seeking to remove penetrating items or fireblocking applications. Include the following information on labels:
 - a. The words: "Warning: Fireblocking Application-Do Not Disturb. Notify Building Management of Any Damage"
 - b. Contractor's name, address, and phone number
 - c. Date of installation
 - d. Fireblocking product manufacturer's name
 - e. Installer's name
- E. Cleaning And Protection
 - 1. Clean off excess fill materials adjacent to openings as work progresses by methods and with cleaning materials that are approved in writing by fireblocking product manufacturer and that do not damage materials in which openings occur.

2. Provide final protection and maintain conditions during and after installation that ensure fireblocking applications are without damage or deterioration at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated fireblocking applications immediately and install new materials to produce fireblocking applications complying with specified requirements.

END OF SECTION 260501

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SECTION 260519-LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes building wire and cable; nonmetallic-sheathed cable; direct burial cable; service entrance cable; armored cable; metal clad cable; and wiring connectors and connections.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. NECA (National Electrical Contractors Association) - Standard of Installation.
- B. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. NFPA 70.
- D. UL – Underwriters Laboratory.
- E. NEMA WC.

1.3 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Stranded conductor for feeders and branch circuits 10 AWG and smaller.
 - 2. Stranded conductors for control circuits.
 - 3. Conductor not smaller than 12 AWG for power and lighting circuits.
 - 4. Conductor not smaller than 14 AWG for control circuits.
 - 5. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than **75 feet**.
 - 6. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than **200 feet**
- B. Wiring Methods: Provide the following wiring methods:
 - 1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.
 - 2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.
 - 3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.
 - 4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.
 - 5. Exterior Locations: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.
 - 6. Underground Locations: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.

1.4 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper.

1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit for building wire and each cable assembly type.
- C. Samples:
 - 1. Submit 1 each, 18 inch length of cable assembly from each reel.
 - 2. Select each length to include complete set of manufacturer markings.
 - 3. Attach tag indicating cable size and application information.
- D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.
- E. Test Reports: Indicate procedures and values obtained.

1.6 CLOSEOUT SUBMITTALS

- A. Section 017700 – Closeout Procedures.
- B. Project Record Documents: Record actual locations of components and circuits.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements are as indicated on Drawings.

1.9 COORDINATION

- A. Section 013300 - Submittals.
- B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- C. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 ft of length shown.

1.10 QUALITY ASSURANCE

- A. Perform Work in accordance with the National Electric Code and the Ohio Building Code, UL and all other codes and ordinances including NEMA 600C.

PART 2 PRODUCTS

2.1 BUILDING WIRE

- A. Manufacturers:
 - 1. American Insulated Wire Corp.
 - 2. Rome Cable Corp.
 - 3. South Wire Co.
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper, 985 conductivity
- D. Insulation Voltage Rating: 600 volts.

2.2 WIRING CONNECTORS

- A. Insulated Compression Connectors: ILSCO, T & B, Burndy

PART 3 EXECUTION

3.1 EXAMINATION

- A. Refer to Division 1 requirements.
- B. Verify interior of building has been protected from weather.
- C. Verify mechanical work likely to damage wire and cable has been completed.
- D. Verify raceway installation is complete and supported.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

- A. Route wire and cable to meet Project conditions.
- B. Install wire and cable in accordance with NECA "Standard of Installation."
- C. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- D. Identify and color code wire and cable under provisions of Section 260553. Identify each conductor with its circuit number or other designation indicated.
- E. Special Techniques--Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.
 - 2. Install building wire 4 AWG and larger with pulling equipment.
- F. Special Techniques - Cable:

1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

G. Special Techniques - Wiring Connections:

1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
7. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
8. Install solid conductor for feeders and branch circuits 10 AWG and smaller.
9. Install stranded conductors for branch circuits 10 AWG and smaller. However, when stranded conductors are used in lieu of solid, then install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

H. PERFORMANCES

1. THHN/THWN for service entrance
2. THHN/THWN for feeders and branch circuits

3.4 WIRE COLOR

A. General

1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.5 FIELD QUALITY CONTROL

- A. Refer to Division 1 requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION 260519

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SECTION 260526-GROUNDING AND BONDING**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Rod electrodes.
 - 2. Wire.
 - 3. Grounding well components.
 - 4. Mechanical connectors.
 - 5. Exothermic connections.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. IEEE 142 (Institute of Electrical and Electronics Engineers) - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- B. IEEE 1100 (Institute of Electrical and Electronics Engineers) - Recommended Practice for Powering and Grounding Sensitive electronic Equipment.
- C. NECA (National Electrical Contractors Association) - Standard of Installation.
- D. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- E. NFPA 70 (National Fire Protection Association) - National Electrical Code.
- F. UL 467.
- G. Bare copper conductors ASTM "B".
- H. UL486A (torque values) and UL486B (wire connectors and devices).

1.3 SYSTEM DESCRIPTION

- A. Grounding systems use the following elements as grounding electrodes:
 - 1. Metal underground water pipe.
 - 2. Metal building frame.
 - 3. Concrete-encased electrode.
 - 4. Metal underground gas piping system.
 - 5. Rod electrode.
 - 6. Plate electrode.

1.4 DESIGN REQUIREMENTS

- A. Construct and test grounding systems in accordance with all applicable codes and standards.

1.5 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms maximum.

1.6 SUBMITTALS

- A. Section 013300- Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Installation Instructions: Submit for active electrodes.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.7 CLOSEOUT SUBMITTALS

- A. Section 017700– Closeout procedures.
- B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.8 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.
- B. Perform Work in accordance with State of Ohio standard.
- C. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.10 PRE-INSTALLATION CONFERENCE

- A. Section 013100 – Project meetings.
- B. Convene minimum one week prior to commencing work of this section.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000- Product Requirements: Requirements for transporting, handling, storing, and protecting products.

- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.12 COORDINATION

- A. Refer to Division 1 Requirements.
- B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

- A. Manufacturers:
 - 1. Erico, Inc.
 - 2. O-Z Gedney Co.
 - 3. IlSCO
- B. Product Description:
 - 1. Material: Copper Clad Steel.
 - 2. Diameter: **3/4 inch.**
 - 3. Length: **10 feet.**
- C. Connector: Connector for exothermic welded connection.

2.2 WIRE

- A. Material: Stranded copper.
- B. Foundation Electrodes: 4/0 AWG.
- C. Grounding Electrode Conductor: Copper conductor bare.
- D. Bonding Conductor: Copper conductor bare.
- E. Branch and feeder circuits to be insulated and colored green.

2.3 MECHANICAL CONNECTORS (Not to be used underground.)

- A. Manufacturers:
 - 1. Erico, Inc.
 - 2. ILSCO Corporation.
 - 3. O-Z Gedney Co.

- B. Furnish materials in accordance with the National Electrical Code.

2.4 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. ILSCO Corporation.
 - 2. O-Z Gedney Co.
 - 3. Erico
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Refer to Division 1 requirements.

3.2 PREPARATION

- A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.3 INSTALLATION

- A. Install in accordance with IEEE 142 and 1100. There shall be continuous equipment grounding throughout the entire power system.
- B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground. Ground resistance shall be less than 5 ohms.
- C. Install grounding and bonding conductors concealed from view.
- D. Install 4/0 AWG bare copper wire in foundation footings and ground and bond foundation reinforcing steel.
- E. Bond together metal siding and roof not attached to grounded structure; bond to ground.
- F. Install ground grid under access floors. Construct grid of 4 AWG bare copper wire installed on 24 inch centers both ways. Bond each access floor pedestal to grid.
- G. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Install 2 AWG bare copper bonding conductor.
- H. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

- I. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- J. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- K. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
- L. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.
- M. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.4 FIELD QUALITY CONTROL

- A. Refer to Division 1 requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground resistance testing in accordance with IEEE 142.
- E. Perform leakage current tests in accordance with NFPA 99.
- F. Perform continuity testing in accordance with IEEE 142.
- G. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION 260526

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SECTION 260529-ELECTRICAL HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Firestopping relating to electrical work.
 - 7. Firestopping accessories.
 - 8. Equipment bases and supports.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
- B. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
- C. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
- D. FM (Factory Mutual Engineering Corporation) - Fire Hazard Classifications.
- E. NFPA 70 (National Fire Protection Association) - National Electrical Code.
- F. NECA (National Electrical Contractors Association) - Standard of Installation.
- G. UL (Underwriters Laboratories, Inc.) - Fire Resistance Directory.
- H. UL 263 (Underwriters Laboratories, Inc.) - Fire Tests of Building Construction and Materials.
- I. UL 723 (Underwriters Laboratories, Inc.) - Test for Surface Burning Characteristics of Building Materials.
- J. UL 1479 (Underwriters Laboratories, Inc.) - Fire Tests of Through-Penetration Firestops.
- K. WH (Warnock Hersey) - Directory of Listed Products.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction in accordance with FM, UL, WH Design Numbers noted on architectural Drawings.
- B. Surface Burning: ASTM E84 and UL 723 with maximum flame spread / smoke developed rating of 25/450.
- C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code, FM, UL, and WH for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

- A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with the National Electric Code and the Ohio Building Code and all other codes and ordinances.

- B. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.9 PRE-INSTALLATION CONFERENCE

- A. Section 013100 – Project Meetings.
- B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.1 COATING

- A. Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.
 - 1. Expansion anchors to be carbon steel wedge or sleeve type.
 - 2. Toggle bolts to be all steel springhead type.

3. Power-driven threaded studs to be heat-treated steel, designed specifically for the intended service.

2.2 CONDUIT SEALING BUSHINGS

- A. Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps and cap screws.

2.3 U-CHANNEL SYSTEMS

- A. U-channel systems to be 12 gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with u-channel and are of the same manufacture.

2.4 HANGERS

- A. Hangers shall be steel ring or clevis type

2.5 MANUFACTURERES

- A. STEEL CITY
- B. UNISTRUT
- C. PHD
- D. ERICO CADDY

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural systems and with other electrical installation.
- C. Raceway supports shall comply with the NEC and the following requirements:
 1. Conform to manufacturer's recommendation for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength of each support.
 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2" and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits.
 6. Space support for raceways in accordance with table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 9. Vertical conductor supports to be installed simultaneously with installation of conductors.
 10. Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
 11. Install sleeves in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL-listed fire stopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Resistant Joint Sealers".
 12. Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- D. Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screw or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a power charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws.

Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration and shock-resistant fasteners for attachments to concrete slabs.

END OF SECTION 260529

SECTION 260533-RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes conduit raceways, and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Conduit fittings.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
- C. ANSI C80.5 - Rigid Conduit.
- D. UL 360– Liquid tight metal conduit
- E. NEMA TC9 – PVC 40 AND 80
- F. NECA (National Electrical Contractor’s Association) - "Standard of Installation"
- G. NEMA FB 1 (National Electrical Manufacturers Association) - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- H. NEMA OS 1 (National Electrical Manufacturers Association) - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- I. NEMA OS 2 (National Electrical Manufacturers Association) - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- J. NEMA RN 1 (National Electrical Manufacturers Association) - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- K. NEMA TC 3 (National Electrical Manufacturers Association) - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- L. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum).
- M. NFPA 70 – National Electrical Code.
- N. Underwriter’s Laboratory (UL)
- O. UL 514A
- P. Canadian Standard Association (CSA)

- Q. Intermediate Metal Conduit (IMC) UL 1242.
- R. Liquidtight Flexible Metal Conduit UL 360.
- S. Underground Polyvinyl Chloride (PVC) Nema TC9.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground More than **5 feet** outside Foundation Wall: Provide schedule 40 nonmetallic conduit encased in concrete, 3" all sides. Provide cast metal boxes or nonmetallic handhole.
- C. Underground Within **5 feet** from Foundation Wall: Provide rigid steel conduit encased in concrete, 3" all sides. Provide cast metal or nonmetallic boxes. Use rigid metal sweeping 90 degree elbows when entering building from below grade.
- D. Under Slab on Grade: Provide Schedule 40 nonmetallic conduit. Provide cast metal boxes. Provide GRC 90's and risers through the slab.
- E. Outdoor Locations, Above Grade: Provide rigid steel. Provide cast metal outlet, pull, and junction boxes.
- F. In Slab Above Grade: Provide schedule 40 nonmetallic conduit. Provide cast metallic boxes.
- G. Wet and Damp Locations: Provide rigid steel metal conduit. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- H. Concealed Dry Locations: Provide electrical metallic tubing with steel set screw fittings. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- I. Exposed Dry Locations: electrical metallic tubing with steel set screw fittings. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- J. PVC Schedule 40 conduit may be for exterior branch circuits. Encase PVC Schedule 40 conduit in 3 inch concrete when under drives and parking areas.

1.4 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: **3/4 inch** unless otherwise specified.

1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.

- B. Product Data: Submit for the following:
 - 1. Liquidtight flexible metal conduit.
 - 2. Nonmetallic conduit.
 - 3. Flexible nonmetallic conduit.
 - 4. Nonmetallic tubing.
 - 5. Raceway fittings.
 - 6. Conduit bodies.
 - 7. Surface raceway.
 - 8. Wireway.
 - 9. Pull and junction boxes.
 - 10. Handholes.
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

- A. Section 017700 - Closeout procedures.
- B. Project Record Documents:
 - 1. Record actual routing of conduits larger than 2 inch trade size.
 - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.8 COORDINATION

- A. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT RACEWAY

- A. Manufacturers:
 - 1. Allied.
 - 2. Wheatland
 - 3. Republic
 - 4. The Wiremold Co.
- B. Rigid Steel Conduit: ANSI C80.1.

- C. Rigid Aluminum Conduit: ANSI C80.5.
- D. Intermediate Metal Conduit (IMC): Rigid steel.
- E. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Panduit
 - 3. Thomas & Betts Corp.
- B. Product Description: Interlocked steel construction.
- C. Fittings: NEMA FB 1.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Panduit
 - 3. Thomas & Betts Corp.
- B. Product Description: Interlocked steel construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.4 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied.
 - 2. Wheatland
 - 3. Republic
 - 4. The Wiremold Co.
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression type.

2.5 NONMETALLIC CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Allied
 - 3. Queen City
- B. Product Description: NEMA TC 2; Schedule 40 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

2.6 WIREWAY

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Walker Systems Inc.
 - 3. The Wiremold Co.
- B. Product Description: General purpose, Oiltight and dust-tight, Raintight type wireway as required.
- C. Knockouts: As required.
- D. Size: **4 x 4 inch, 6 x 6 inch, 8 x 8 inch, and 12 x 12 inch**; length as indicated on Drawings.
- E. Cover: Hinged cover with full gaskets.
- F. Connector: Slip-in or Flanged as required.
- G. Fittings: Lay-in type with removable side; captive screws, drip shield.
- H. Finish: Rust inhibiting primer coating with gray enamel finish.
- I. 16 gauge galvanized construction with ANSI-49 epoxy gray paint.
- J. Sufficient size to accommodate all cables and wires installed.
- K. NEMA 12 rating on interior of building.
- L. NEMA 4 water and oil tight and exterior locations

2.7 OUTLET BOXES

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. RACO
 - 3. Steel City
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
- C. Nonmetallic Outlet Boxes: NEMA OS 2.
- D. Cast Boxes: NEMA FB 1, Type FS, cast ferrous alloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- E. Wall Plates for Finished Areas: As specified in Section 262726.
- F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

- G. Minimum depth for boxes is 2 inches, data/video and voice are to be 2 gang and 3 ½ inches minimum depth.

2.8 PULL AND JUNCTION BOXES

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. RACO.
 - 3. Steel City
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Screw Cover Enclosures: As specified in Section 16131.
- D. Surface Mounted Cast Metal Box: NEMA 250, Type 1; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- E. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 - 3. Cover Legend: "ELECTRIC".
- F. Fiberglass Concrete composite Handholes: Die-molded, glass-fiber concrete composite hand holes:
 - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
 - 2. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Refer to Division 1 requirements.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

- A. Install Work in accordance with State Ohio standards.
- B. Install raceway and boxes in accordance with NECA "Standard of Installation."
- C. Ground and bond raceway and boxes in accordance with Section 260526.

- D. Fasten raceway and box supports to structure and finishes in accordance with Section 260529.
- E. Identify raceway and boxes in accordance with Section 260553.
- F. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 260529; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 260529.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit under slab from point-to-point.
- K. Maximum Size Conduit in Slab Above Grade: **3/4 inch**. Do not cross conduits in slab.
- L. Maintain clearance between raceway and piping for maintenance purposes.
- M. Maintain **12 inch** clearance between raceway and surfaces with temperatures exceeding **104 degrees F**.
- N. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- O. Bring conduit to shoulder of fittings; fasten securely.
- P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

- R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams.
- S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- X. Close ends and unused openings in wireway.
- Y. Install underground conduits a minimum of 36 inches below finished grade.
- Z. Install below slab conduits a minimum of 12 inches below the slab.
- AA. EMT may be used in the interior of the building in dry locations; PVC 40 installed 6 inches below the slab with GRC turn ups through the slab may be used; wet locations and exposed to potential damage are to be GRC; PVC 40 in masonry walls may be used. Exterior underground conduits used for feeders shall be concrete encased with a 4 inch envelope a minimum of 36 inches below grade and shall be PVC 40. Exterior underground conduits used for branch circuits shall be premium fill encased with a 4 inch envelope, except proved a 4 inch concrete envelope under drives and parking areas, a minimum of 36 inches below grade and shall be PVC 40.
- BB. Each conduit shall have an equipment ground conductor sized in accordance with the NEC.
- CC. Raceways shall be concealed unless otherwise noted.

3.4 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights.
- B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 262726.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum **6 inches** separation. Install with minimum **24 inches** separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified in other sections
- C. Locate outlet boxes to allow luminaires positioned as indicated on architectural reflected ceiling plan.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused openings in boxes.

3.7 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION 260533

SECTION 260534-CABINETS AND ENCLOSURES FOR ELECTRICAL SYSTEMS**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes hinged cover enclosures, cabinets, terminal blocks, and accessories.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. NECA (National Electrical Contractors Association) -Standard of Installation.
- B. NEMA ICS 4 (National Electrical Manufacturers Association) - Terminal Blocks for Industrial Control Equipment and Systems.
- C. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturer's standard data for enclosures, cabinets, and terminal blocks.
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.5 EXTRA MATERIALS

- A. Section 017700 – Closeout procedures.
- B. Furnish two of each key.

PART 2 PRODUCTS**2.1 HINGED COVER ENCLOSURES**

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Hubbell Wiring Devices.
 - 3. Reliance Electric.
 - 4. Hoffman.

5. Appleton.
6. Thomas & Betts.
7. Walker Systems.

- B. Construction: NEMA 250, Type 1 steel enclosure.
- C. Covers: Continuous hinge, held closed by flush latch operable by key.
- D. Furnish interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.
- E. Enclosure Finish: Manufacturer's standard gray enamel.

2.2 CABINETS

- A. Manufacturers:
 1. Carlon Electrical Products.
 2. Hubbell Wiring Devices.
 3. Reliance Electric.
 4. Hoffman.
 5. Appleton.
 6. Thomas & Betts.
- B. Boxes: Galvanized steel.
- C. Box Size: Indicated on drawings.
- D. Backboard: Furnish 1/8 inch thick steel backboard for mounting terminal blocks. Paint matte white.
- E. Fronts: Steel, flush or surface type, as noted, with concealed trim clamps, door with concealed hinge, and flush lock [keyed to match branch circuit panelboard]. Finish with gray baked enamel.
- F. Furnish metal barriers to form separate compartments wiring of different systems and voltages.
- G. Furnish accessory feet for free-standing equipment.

2.3 PLASTIC RACEWAY

- A. Manufacturers:
 1. Carlon Electrical Products.
 2. Hubbell Wiring Devices.
 3. Reliance Electric.
 4. Hoffman.
- B. Product Description: Plastic channel with hinged or snap-on cover.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation."
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner in accordance with Section 260529.
- C. Install cabinet fronts plumb.

3.2 CLEANING

- A. Clean electrical parts to remove conductive and harmful materials.
- B. Remove dirt and debris from enclosure.
- C. Clean finishes and touch up damage.

END OF SECTION 260534

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SECTION 260536 – CABLE TRAY**PART 1 – GENERAL****1.1 SUMMARY**

- A. Furnish and install all materials, labor, equipment, permits, etc., to provide facilities as described herein and illustrated on the Drawings for a complete functional system.
- B. All materials, unless otherwise specified, shall be new, free from any defects and of the best quality of their respective kinds. All like materials used shall be of the same manufacturer, model, and quality, unless otherwise specified.
- C. All manufactured articles, material, and equipment shall be applied, installed connected, erected, used, cleaned, adjusted, and conditioned as recommended by the manufacturers, or as indicated in their published literature, unless specifically herein specified to the contrary.
- D. All work shall be performed by competent workmen and executed in a neat and workmanlike manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials. At completion, the installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of this portion of work shall be removed from the premises.
- E. The Contractor must demonstrate to the Owner and Engineer that the system is complete and complies with all operational requirements set forth in the plans and specifications. The Contractor shall provide all miscellaneous items and accessories required to make the system functional and comply with ANSI/EIA/TIA 569 whether or not such items are specifically mentioned in the plans and specifications. It is the Contractor's responsibility to review the architectural, structural, mechanical, and electrical drawings, as well as the specifications, for any details that may impact the installation or provisioning of the system. Any discrepancies discovered shall be brought to the attention of the Engineer.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturers data sheets on all system components. Data sheets shall be neatly bound with title page, index/bill of materials, and tab dividers for each major section. If multiple products or configurations are shown on a page, the product and/or configuration to be supplied and installed in this project shall be highlighted.
- B. Specification sheets shall be submitted on ALL items.

1.3 SUBSTITUTIONS

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days-prior to bid date and submitted in writing to the Construction Manager.

1.4 QUALITY ASSURANCE

- A. The intent of this specification is to describe and provide for a complete system of professional quality in compliance with all ANSI/EIA/TIA 569 standards for telecommunications pathways.
- B. The supplier or sub-contractor for these systems must be a single firm whose primary business is the supply and installation of systems described herein.
- C. The supplier or sub-contractor must show a successful record of installations of similar size and complexity over the past five years that were installed and commissioned by their own forces.
- D. All work under this specification will be performed under the supervision of an individual who is experienced with the requirements for installation of a system as described herein, and documented successful experience testing, adjusting, balancing, equalizing, and operating said systems.
- E. This Contractor is responsible for coordinating all rough-in locations with actual equipment furnished, and verification of dimensions and conditions at the job site, which might affect the systems installation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver all system components properly packaged in factory-fabricated type containers.
- B. Store components in original cartons and in a clean dry space; protect from weather and construction traffic.
- C. Handle equipment and components carefully to avoid breakage, impacts, denting and scoring finishes. Do not install any damaged equipment; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other work, including electrical wiring work, as necessary to interface installation with other work.
- B. Sequence installation work with other work to minimize possibility of damage and soiling system during remainder of the construction period.

1.7 SCOPE

- A. Furnish and install a wall mounted flexible basket type cable tray system complete with all fittings in accordance with requirements outlined in this specification.

- B. Non-basket type cable tray systems will **not** be accepted.
- C. All equipment shall comply with the applicable sections of the following:
- D. NFPA 70 (NEC)
 - 1. UL Listed
 - 2. NEMA VE-1.
 - 3. ANSI/EIA/TIA 569

PART 2 – PRODUCTS

2.1 STANDARDS

- A. Basket cable tray shall have minimum depth of 4" and 2"x4" grid spacing. The inside depth shall be 3-5/8" and 18" wide (unless noted otherwise on plans).
- B. Cable tray shall be either mill galvanized or electroplated zinc after manufacturing.
- C. Basket cable tray must be UL approved, labeled for use as an equipment ground conductor and comply with all NEMA standards concerning radius, load capacity, depth, and supporting means.
- D. If the cable tray is not labeled for use as an equipment ground conductor, each joint shall be connected with bonding conductors for an absolute ground.
- E. **Design Basis 18" Cable Tray** – Chatsworth Products #13343-018 or equal by Cope #CAT 4 WSL 120 and Chalfant #WMST 418 G.

2.2 ACCESSORIES

- A. All items such as barrier strips (if required), special splices, wall and ceiling hangers, hold down clips, box connectors, end plates, etc. and shall be furnished as necessary for a complete installation.
- B. Provide radius fittings, dropouts and all other required accessories to transition from the cable tray to the racks, cabinets and backboards in the Technology Closets.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide basket cable tray above corridor ceiling along entire corridor span. Cable tray shall be installed utilizing wall-mount brackets, where field conditions allow, along the edge of the corridor as shown on the detailed plans.
- B. Provide cable tray in the Technology Control Room (ER) and Technology Rooms (TR)

as shown on the detailed plans.

- C. Maintain 12" clear space from fluorescent light fixtures, 6" clear space from the top of the cable tray to any obstruction, 6" clear space from bottom of cable tray to above the ceiling height, and 36" clear space from any transformer.
- D. The contractor shall be responsible for the coordination of the cable tray placement to ensure the proper clearances and mounting locations can be obtained.
- E. If 6" clear space from the top of the cable tray can not be maintained, the contractor shall provide (3) 4" sleeves through the obstructed area.

3.2 FIRESTOPPING

- A. Firestop all wall and floor penetrations with an approved, reusable UL listed firestop system utilizing an intumescent material and pre-fabricated as a through the wall device for cable passage.
- B. System shall be STI EZpath systems or equal by CSD or Hilti.
- C. Provide shop drawings detailing the firestop system to be used for each rated wall penetration, and provide 1/8" = 1' floor plan drawings showing all penetrations with unique label for each rated wall penetration. Firestop system shop drawings shall list all rated wall penetration ID's that the submitted firestop system drawings will be used for.
- D. Document with pictures each completed and approved firestop system installation and include as part of the as-built documentation and owners manuals. Identify each firestop with the unique label as assigned in the shop drawing process.

3.3 GROUNDING AND BONDING

- A. All equipment shall be bonded in accordance to the latest ratified edition of ANSI/EIA/TIA-607.
- B. Provide a continuous #4 AWG bare ground conductor in the cable tray bonded to each section and routed continuous into and between all technology rooms and all lengths of cable tray.

3.4 PERMITTED USE

- A. Only data and voice cables may occupy cable tray.
- B. Fire alarm, PA systems, video, and other low voltage systems shall be in separate j-hook support system.
- C. Bundle all like cable types together and place in same area of cable tray.

END OF SECTION 260536

SECTION 260553-IDENTIFICATION FOR ELECTRICAL SYSTEMS**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Nameplates.
 - 2. Labels.
 - 3. Wire markers.
 - 4. Conduit markers.
 - 5. Underground Warning Tape.
 - 6. Lockout Devices.
- B. Related Sections:
 - 1. Section 099000 - Paints and Coatings: Execution requirements for painting specified by this section.

1.2 SUBMITTALS AND QUALITY ASSURANCE

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
- C. Samples:
 - 1. Submit two tags, actual size.
 - 2. Submit two labels, actual size.
 - 3. Submit two nameplates, 4 x 4 inch in size illustrating materials and engraving quality.
- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

- A. Section 017700 – Closeout Procedures.
- B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with State standard.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept identification products on site in original containers. Inspect for damage.
- C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

1.8 EXTRA MATERIALS

- A. Section 017700 – Closeout Procedures.

1.9 CERTIFICATION

- A. Equipment Identification shall be in accordance with ASTM E A13.1

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
- B. Letter Size:
 - 1. **1/8 inch** high letters for identifying individual equipment and loads.
 - 2. **1/4 inch** high letters for identifying grouped equipment and loads.
- C. Minimum nameplate thickness: **1/8 inch**.

2.2 LABELS

- A. Labels: Riveted engraved phenolic, with **3/16 inch** white letters on black background.

2.3 WIRE MARKERS

- B. Description: Split sleeve or tubing type wire markers.
- C. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
 - 2. Control Circuits: Control wire number as indicated on schematic interconnection diagrams and Drawings.

2.4 CONDUIT AND RACEWAY MARKERS

- A. Description: Nameplate fastened with adhesive or Labels fastened with adhesive.
- B. Color:
 - 1. Medium Voltage System: White lettering on black background.
 - 2. 480 Volt System: Black lettering on white background.
 - 3. 208 Volt System: Black lettering on white background.
 - 4. Fire Alarm System: Red lettering on white background.
 - 5. Telephone System: Blue lettering on white background.
- C. Legend:
 - 1. Medium Voltage System: HIGH VOLTAGE.
 - 2. 480 Volt System: 480 VOLTS. HIGH VOLTAGE.
 - 3. 208 Volt System: 208 VOLTS.
 - 4. Fire Alarm System: FIRE ALARM.
 - 5. Telephone System: TELEPHONE.

2.5 UNDERGROUND WARNING TAPE

- A. Description: 4 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

2.6 LOCKOUT DEVICES

- A. Lockout Hasps: Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 099000 for stencil painting.

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:

1. Install nameplate parallel to equipment lines.
 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
 4. Secure nameplate to equipment front using screws or adhesive.
 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
 6. Install nameplates for the following:
 - a. Switchboards.
 - b. Panelboards.
 - c. Transformers.
 - d. Service Disconnects and starters
- C. Label Installation:
1. Install label parallel to equipment lines.
 2. Install label for identification of individual control device stations.
 3. Install labels for permanent adhesion and seal with clear lacquer.
- D. Wire Marker Installation:
1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.
 2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
 3. Install labels at data outlets identifying patch panel and port designation as indicated on Drawings.
- E. Conduit/Raceway Marker Installation:
1. Install conduit/raceway marker for each conduit/raceway longer than **6 feet**.
 2. Conduit/Raceway Marker Spacing: **20 feet** on center.
 3. Raceway Painting: Identify conduit using field painting in accordance with Section 099000.
 - a. Paint colored band on each conduit longer than **6 feet**.
 - b. Paint bands **20 feet** on center.
 - c. Color:
 - 1) 480 Volt System: Orange.
 - 2) 208 Volt System: Yellow.
 - 3) Fire Alarm System: Red.
 - 4) Telephone System: Blue.
- F. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable **6 to 8 inches** below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION 260553

SECTION 260800 – ELECTRICAL SYSTEMS COMMISSIONING**PART 1 - GENERAL****1.1 COMMISSIONING AUTHORITY**

- A. The commissioning authority (CA) has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However commissioning involves all parties to the design and construction process, including the Electrical (Division 26) contractor and major equipment suppliers as required.

1.2 CONTRACTOR RESPONSIBILITY

- A. The Electrical (Division 26) contractor's responsibilities are defined in Section 019100 of the specifications. These responsibilities apply to all specialty sub-contractors and major equipment suppliers within Division 26. Each contractor and supplier shall review Section 019100, and their bids shall include for carrying out the work described, as it applies to each Section within the Division 26 specifications, individually and collectively.

PART 2 - PRODUCTS (Not Used)**PART 3 - EXECUTION (Not Used)**

END OF SECTION 260800

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SECTION 262613-FUSES**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes fuses, fuse holders and spare fuse cabinet.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. NEMA FU 1 (National Electrical Manufacturers Association) - Low Voltage Cartridge Fuses.
- B. NFPA 70 – National Electrical Code.
- C. Underwriter’s Laboratory.
- D. Cartridge Fuses: NEMA FU 1, ANSI/IEEE FU 1.

1.3 DESIGN REQUIREMENTS

- A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.
- B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

1.4 FUSE PERFORMANCE REQUIREMENTS

- A. Main Service Switches Larger than 600 amperes: Class L [(time delay).
- B. Main Service Switches: Class RK1 (time delay).
- C. Power Load Feeder Switches Larger than 600 amperes: Class L [(time delay).
- D. Power Load Feeder Switches: Class RK1 [(time delay).
- E. Motor Load Feeder Switches: Class RK1 (time delay).
- F. Other Feeder Switches Larger than 600 amperes: Class L time delay.
- G. Other Feeder Switches: Class RK1 (time delay).
- H. General Purpose Branch Circuits: Class RK1 (time delay).
- I. Motor Branch Circuits: Class RK5 (time delay).

1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.6 CLOSEOUT SUBMITTALS

- A. Section 017700 - Closeout procedures.
- B. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 MAINTENANCE MATERIALS

- A. Refer to Division 1 requirements.
- B. Furnish two fuse pullers.

1.9 EXTRA MATERIALS

- A. Refer to Division 1 requirements.
- B. Furnish three spare fuses of each Class, size, and rating installed.

PART 2 PRODUCTS

2.1 FUSES

- A. Manufacturers:
 - 1. Gould – Shawmet.
 - 2. Bussman.
 - 3. Little Fuse.
- B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.
- C. Voltage: Rating suitable for circuit phase-to-phase voltage.
- D. Low voltage fuses shall be Class R or Class L rejection type, time delay, high interrupting, current limiting, dual element.
- E. Fuses rated 601 amp through 6000 amp to be NEMA Class “L” and U.L. approved for 200,000 amps RMS symmetrical interrupting capacity.

- F. Fuses rated 0 through 600 amp to be NEMA Class “RK1” and U.L. approved for 200,000 amps RMS symmetrical interrupting capacity.
- G. Fuses shall be nonrenewable cartridge type, noninterchangeable type.
- H. Spare Fuse Cabinet: Wall-mounted 18 gage steel unit.
- I. Three spare fuses for each type and size.

2.2 CLASS RK1 (TIME DELAY) FUSES

- A. Manufacturers:
 - 1. Gould Shawmet.
 - 2. General Electric.
 - 3. Bussman.
 - 4. Little Fuse.
- B. Dimensions and Performance: NEMA FU 1.
- C. Voltage: Rating suitable for circuit phase-to-phase voltage.
- D. Construction: Spring clip type.

2.3 CLASS L (TIME DELAY) FUSES

- A. Manufacturers:
 - 1. Gould Shawmet.
 - 2. General Electric.
 - 3. Bussman.
 - 4. Little Fuse.
- B. Dimensions and Performance: NEMA FU 1.
- C. Voltage: Rating suitable for circuit phase-to-phase voltage.
- D. Construction: Bolt mounted.

2.4 SPARE FUSE CABINET

- A. Product Description: Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified.
- B. Doors: Hinged, with hasp for Owner's padlock.
- C. Finish: Gray enamel.

PART 3 EXECUTION

3.1 INSTALLATION

- D. Install fuse with label oriented so manufacturer, type, and size are easily read.

- E. Install spare fuse cabinet.

END OF SECTION 262613

SECTION 262726-WIRING DEVICES**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and technology floor box.
- B. Related Sections:
 - 1. Section 260533 - Raceway and Boxes for Electrical Systems

1.2 REFERENCES AND QUALITY ASSURANCE

- A. Wall Switches – UL 20, NEMA WD 1.
- B. NEMA WD 1 (National Electrical Manufacturers Association) - General Requirements for Wiring Devices.
- C. NEMA WD 6 (National Electrical Manufacturers Association) - Wiring Device -- Dimensional Requirements.
- D. Floor Boxes – Underwriters Laboratory Listed.
- E. Wall Plates – Underwriter’s Laboratory 514, Canadian Standard Association.
- F. Technology Floor Box – Underwriter’s Laboratory 514A.
- G. NFPA 70 – National Electric Code.
- H. Duplex Receptacles – UL 498, NEMA WD1
- I. UL 486A (torque values) and UL486B (connector and device).

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Samples: Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 EXTRA MATERIALS

- A. Refer to Division 1 requirements.
- B. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.1 WALL SWITCHES

- A. Manufacturers:
 - 1. Bryant
 - 2. Hubbell.
 - 3. Leviton Mfg.
- B. Product Description: NEMA WD 1, Heavy-Duty, AC only general-use snap switch.
- C. Body and Handle: Ivory plastic with toggle handle.
- D. Specified grade, with ground screw.
- E. Ratings:
 - 1. Voltage: 120-277 volts, AC.
 - 2. Current: 20 amperes.

2.2 WALL DIMMERS

- A. Manufacturers:
 - 1. Arrow Hart Wiring Devices.
 - 2. Eagle Electric.
 - 3. Lutron
 - 4. Hubbell.
 - 5. Leviton Mfg.
- B. Product Description: NEMA WD 1; Semiconductor dimmer for incandescent lamps, Type as indicated on Drawings or in schedule.
- C. Architectural grade, rotary knob series.
- D. Body and Handle: Ivory plastic with linear slide.
- E. Voltage: 120 volts.
- F. Power Rating: 1000 watts minimum.
- G. Accessory Wall Switch: Match dimmer appearance.

2.3 RECEPTACLES

- A. Manufacturers:
 - 1. Arrow Hart Wiring Devices.

2. Eagle Electric.
 3. Square D.
 4. Hubbell.
 5. Leviton.
- B. Product Description: NEMA WD 1, Heavy-duty general use receptacle.
- C. Device Body: **Ivory plastic with 302 Stainless Steel cover plates.**
- D. Configuration: NEMA WD 6, type.
- E. Convenience Receptacle: Type 5-20.
- F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
- G. 1-pole, 3 wire, grounding.
- H. 20 amp, 125 volt rated.
- I. Specification grade, Duplex, back and side wired, brass back strap
- J. Receptacles designated as general use shall be of a different color from those designated as computer receptacles.
- K. Ground fault protection where required shall be built into receptacle.

2.4 WALL PLATES

- A. Manufacturers:
1. Arrow Hart Wiring Devices.
 2. Eagle Electric.
 3. Square D.
 4. Hubbell.
 5. Leviton.
- B. Cover Plate: 302 stainless steel, 32D finish
- C. Weatherproof Cover Plate: Stainless steel plate with hinged and gasketed device cover.
- D. Configuration of plates to match devices.

2.5 MULTIOUTLET ASSEMBLY

- A. Manufacturers:
1. Arrow Hart Wiring Devices.
 2. Eagle Electric.
 3. Square D.
 4. Hubbell.
 5. Wiremold

- B. Multi-outlet Assembly: Sheet metal channel with fitted cover, suitable for use as multi-outlet assembly.
- C. Receptacles: Furnish covers and accessories to accept convenience receptacles specified in this Section.
- D. Receptacles: NEMA WD 6, type 5-20R, single receptacle.
- E. Receptacle Spacing: 6 inches as indicated on Drawings.
- F. Receptacle Color: Ivory.
- G. Channel Finish: Ivory enamel.
- H. Fittings: Furnish manufacturer's standard couplings, elbows, outlet and device boxes, and connectors.

2.6 TECHNOLOGY FLOOR BOX

- A. Load bearing steel plate with finish floor recess.
- B. Angle floor access outlets.
- C. Separate concrete form box.
- D. Metal divider between 120 volt and communications compartment.
- E. Metal outlet and device boxes.
- F. Watertight floor box with cover suitable for intended use.
- G. Boxes shall have a minimum depth of 2 inches.
- H. Acceptable mfg's are Hubbell, Wiremold and Walker

PART 3 EXECUTION

3.1 EXAMINATION

- A. Refer to Division 1 requirements.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and completely covered by wall plates.
- D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation."
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- E. Do not share neutral conductor on load side of dimmers.
- F. Install receptacles with grounding pole on bottom.
- G. Connect wiring device grounding terminal to outlet box with bonding jumper used except where IG is.
- H. Install 302 stainless steel plates on switch, receptacle, and blank outlets in finished areas.
- I. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.
- J. Use standard size plates for outlets installed in masonry walls.
- K. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- L. Provide receptacles on roof as required by National Electric Code.
- M. Toggle type in classrooms and key type in public areas.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided to obtain mounting heights as specified and as indicated on drawings.
- B. Outlet boxes for data/voice and voice outlets shall be 2 gang with minimum depth of 3-1/2 inches.
- C. Install wall switch **48 inches** above finished floor.
- D. Install convenience receptacle **18 inches** above finished floor.
- E. Install convenience receptacle **6 inches** above counter.
- F. Install dimmer **48 inches** above finished floor.

3.5 FIELD QUALITY CONTROL

- A. Refer to Division 1 requirements.
- B. Inspect each wiring device for defects.
- C. Operate each wall switch with circuit energized and verify proper operation.
- D. Verify each receptacle device is energized.
- E. Test each receptacle device for proper polarity.
- F. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

- A. Section 017000 - Execution Requirements: Testing, adjusting, and balancing.
- B. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

SECTION 262816-ENCLOSED SWITCHES**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes fusible and non-fusible safety switches.
- B. Related Sections:
 - 1. Section 262816 - Fuses.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. NECA (National Electrical Contractors Association) -Standard of Installation.
- B. NEMA FU 1 (National Electrical Contractors Association).- Low Voltage Cartridge Fuses.
- C. NEMA KS 1 (National Electrical Contractors Association).- Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- D. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).
- E. UL 98
- F. Underwriters Laboratory
- G. NFPA 70

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017700 - Closeout procedures.
- B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with the National Electric Code and the Ohio Building Code, UL 98, and all other codes and ordinances.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. GE Electrical.
 - 2. Square "D".
 - 3. Cutler Hammer
 - 4. Siemens.
- B. Product Description: NEMA KS 1, Type HD heavy duty with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle pad lockable in OFF position. Totally enclosed with external operating handle and mechanical cover interlock. Internal ground lug
- C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.
- D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.
- E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
- F. Furnish switches with entirely copper current carrying parts.
- G. Rating shall be suitable for use

2.2 NONFUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. GE Electrical.
 - 2. Square "D".
 - 3. Westinghouse Electric Corp.
 - 4. Siemens.
- B. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

- D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
- E. Furnish switches with entirely copper current carrying parts.

2.3 SWITCH RATINGS

- A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
- B. Short Circuit Current Rating: See one line, otherwise use UL listed for 10,000 rms symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere). 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes). 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation."
- B. Install enclosed switches plumb. Provide supports in accordance with Section 260529.
- C. Height: 5 ft to operating handle.
- D. Install fuses for fusible disconnect switches.
- E. Install engraved nameplates in accordance with Section 260553.
- F. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

- A. Refer to Division 1 requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 262816

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SECTION 262913- MOTOR CONTROLLERS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of contract, including general and supplementary conditions and Division 1 specification section, apply to this section.

1.2 SUMMARY

- A. This section includes A.C. motor control centers and devices rated 600v and below.

1.3 DEFINITIONS

- A. Motor control center: A packaged enclosure in a NEMA 1 enclosure that contains devices that control, protect, and energize an electric motor or other loads, and where required, controls its speed or the torque or power delivered by it. It is prewired.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with conditions of contract and Division 1 specification sections or herein.
- B. Product data for products specified in this section. Include dimensions, ratings, and data on features and components.
- C. Certified reports of field tests and observations specified in "Field Quality Control" in this section.
- D. Maintenance data for products for inclusion in operating and maintenance manuals specified in Division 1 and in Division 26.
- E. Qualification data for field-testing organization certificates, signed by the contractor, certifying that the organization complies with the requirements specified in "Quality Assurance" below. Include list of completed projects with project names, addresses, names of architects and owner, plus other information specified.

1.5 REFERENCE AND QUALITY ASSURANCE

- A. Components and installation: NFPA 70 "National Electrical Code", latest edition.
- B. Listing and labeling: Provide products specified in this section that are listed and labeled.
 - 1. The terms "Listed" and "Labeled" shall be defined as they are in the National Electrical Code, article 100.
- C. NEMA compliance: NEMA ICS 2, "Industrial Control Devices, Controllers and Assemblies".

- D. UL compliance: UL 508, "Electric Industrial Control Equipment".
- E. Single-source responsibility: Obtain similar motor-control devices from a single manufacturer.

1.6 COORDINATION

- A. General: Coordinate features of controllers and control devices with pilot devices and control circuits provided under Division 23 sections covering control systems.

1.7 EXTRA MATERIALS

- A. Spare fuses and incandescent indicating lamps: Furnish one spare for every 5 installed units, but not less than one set of 3 of each kind.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include the following:

1. Siemens	2. Square D
3. General Electric	4. Cutler Hammer
5. Allen Bradley	

2.2 MOTOR CONTROLLERS, GENERAL

- A. Coordinate the features of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, the duty cycle of the motor, drive, and load, and the pilot device, and control circuit affecting controller functions. Provide controllers that are horsepower rated to suit the motor controlled.
- B. Contacts shall open each ungrounded connection to the motor.
- C. Overload relays: Solid state or BI-metal overload protection with trip class 20. Unit shall be manual reset.

2.3 MAGNETIC MOTOR CONTROLLERS

- A. Description: Provide full-voltage, nonreversing, across-the-line, magnetic controller, except where another type is indicated.
- B. Control circuit: 120 V. provide control power transformer integral with controller where no other supply of 120 v control power to controller is indicated. Provide control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
- C. Combination controller: Circuit breaker type; factory assembled with controller and

arranged to disconnect it. Interlock switch with unit cover or door.

2.4 AUXILIARY CONTROL DEVICES

- A. Hand-off-auto selector, green and red pilot lights and 2 N.O. and 2 N.C. auxiliary contacts. Heavy duty type.
- B. Phase-failure for 3 phase motors and undervoltage relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.5 APPLICATION

- A. Manual controllers: Use as noted on drawings.
- B. Hand-off-automatic selector switches: Except as otherwise indicated, install in covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment. Make control connections so only the manual and automatic control devices that have no safety functions will be bypassed when the switch is in the hand position. Connect motor-control circuit in both hand and automatic positions for safety type control devices such as low and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors. Make control-circuit connections to a hand-off automatic switch or to more than one automatic control device in accordance with an indicated wiring diagram or one that is manufacturer approved.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install in accordance with manufacturer's written instructions.
- B. Manufacturer's field services: Arrange and pay for the services of a factory-authorized service representative to inspect the field assembly and connection of components, and supervise the pretesting and adjustment of solid-state controllers.

3.2 IDENTIFICATION

- A. Identify motor control components and control wiring in accordance with section 260553.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between motor control devices and control/indicating devices.
- B. Install wiring in enclosures neatly bundles, trained, and supported.

3.4 CONNECTIONS

- A. Tighten connectors, terminals, bus joints, and mountings. Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment

manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, comply with tightening torques specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Reports: Prepare written reports by testing organization of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.
- B. Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.
- C. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.
- D. Pretesting: On completing installation of the system, perform the following preparations for tests:
 - 1. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.
 - 2. Make continuity tests of circuits.
 - 3. Provide set of contract documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original contract documents.
 - 4. Provide manufacturer's instructions for installation and testing of motor control devices to test personnel.
- E. Visual and mechanical inspection: Include the following inspections and related work.
 - 1. Motor-control device ratings and settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.
 - 2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
 - 3. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.
 - 4. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.

5. Clean devices using manufacturer's approved methods and materials.
 6. Verify proper fuse types and ratings in fusible devices.
- F. Electrical tests: Perform the following in accordance with manufacturer's instructions:
1. Insulation resistance test of motor control devices conducting parts to the extent permitted by the manufacturer's instructions. Insulation resistance less than 100 megohms is not acceptable.
 2. Make adjustments for final settings of adjustable-trip devices.
 3. Test auxiliary protective features such as loss of phase, phase unbalance and undervoltage to verify operation.
 4. Check for improper voltages at terminals in controllers that have external control wiring when controller disconnect is opened. Any voltage over 30v is unacceptable.
- G. Correct deficiencies and retest motor control devices. Verify by the system tests that specified requirements are met.

3.6 CLEANING

- A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally using methods and materials as recommended by manufacturer.

3.7 DEMONSTRATION

- A. Training: Arrange and pay for the services of a factory authorized service representative to demonstrate solid-state and variable-speed controllers and train owner's maintenance personnel.

END OF SECTION 262913

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SECTION 262914-ENCLOSED CONTACTORS**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes enclosed contactors for lighting and general purposes.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. NECA (National Electrical Contractors Association) - Standard of Installation.
- B. NEMA AB 1 (National Electrical Manufacturers Association) - Molded Case Circuit Breakers.
- C. NEMA FU 1 (National Electrical Manufacturers Association) - Low Voltage Cartridge Fuses.
- D. NEMA ICS 2 (National Electrical Manufacturers Association) - Starters, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC.
- E. NEMA ICS 5 (National Electrical Manufacturers Association) - Industrial Control and Systems: Control Circuit and Pilot Devices.
- F. NEMA ICS 6 (National Electrical Manufacturers Association) - Industrial Control and Systems: Enclosures.
- G. NEMA KS 1 (National Electrical Manufacturers Association) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- H. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit dimensions, size, voltage ratings and current ratings.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017700 - Closeout procedures.
- B. Project Record Documents: Record actual locations and ratings of enclosed contactors.
- C. Operation and Maintenance Data: Submit instructions for replacing and maintaining coil and contacts.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 GENERAL PURPOSE CONTACTORS

- A. Manufacturers:
 - 1. Square "D".
 - 2. General Electric.
 - 3. Cutler Hammer
 - 4. Automatic Switch Co.
 - 5. Zenith Controls.
 - 6. Siemens
- B. Product Description: NEMA ICS 2, AC general purpose magnetic contactor.
- C. Coil operating voltage: 120 volts, 60 Hertz.
- D. Poles: To match circuit configuration and control function.
- E. Product Features:
 - 1. Cover Mounted Pilot Devices: NEMA ICS 5, heavy-duty oiltight type with Form Z contacts, rated A150.
 - 2. Pushbutton: ON/OFF function, with unguarded lockable configuration.
 - 3. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
 - 4. Indicating Light: RED lens, with led lamp.
 - 5. Auxiliary Contacts: One, normally open and normally closed field convertible in addition to seal-in contact.
 - 6. Relays: NEMA ICS 2.
 - 7. Control Power Transformers: 120 volt secondary, 100 VA minimum, in each enclosed contactor. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
- F. Combination Contactors: Combine contactors with enclosed knife switch conforming to NEMA KS 1, with externally operable handle and fuse clips designed to accommodate NEMA FU 1, Class R fuses.
- G. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.
 - 3. Wet Locations: Type 4.

2.2 LIGHTING CONTACTORS

- A. Manufacturers:
 - 1. Square "D".
 - 2. General Electric.
 - 3. Westinghouse.
 - 4. Automatic Switch Co.
 - 5. Zenith Controls.
- B. Product Description: NEMA ICS 2, magnetic lighting contactor.
- C. Configuration: Electrically held or Mechanically held, 3 wire control specified in detail.
- D. Coil operating voltage: 120 volts, 60 Hertz.
- E. Poles: To match circuit configuration and control function.
- F. Contact Rating: Match branch circuit overcurrent protection, considering derating for continuous loads.
- G. Accessories:
 - 1. Cover Mounted Pilot Devices: NEMA ICS 5, heavy-duty oiltight type with Form Z contacts, rated A150.
 - 2. Pushbutton: ON/OFF function, with unguarded lockable configuration.
 - 3. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
 - 4. Indicating Light: RED lens, with led lamp.
 - 5. Auxiliary Contacts: One, normally open and normally closed field convertible in addition to seal-in contact.
 - 6. Relays: NEMA ICS 2.
 - 7. Control Power Transformers: 120 volt secondary, 100 VA minimum, in each enclosed contactor. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
- H. Combination Contactors: Combine contactors with enclosed knife switch conforming to NEMA KS 1, with externally operable handle and fuse clips designed to accommodate NEMA FU 1, Class R fuses.
- I. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.
 - 3. Wet Locations: Type 4.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed contactors, in accordance with NECA "Standard of Installation."

- B. Install enclosed contactors plumb. Provide supports in accordance with Section 260529.
- C. Height: 5 ft to operating handle.
- D. Install fuses for fusible switches. .
- E. Install engraved plastic nameplates.

3.2 FIELD QUALITY CONTROL

- A. Refer to Division 1 requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION 262914

SECTION 264315 - SCOREKEEPING SYSTEM**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Scoreboard and accessories.

1.2 QUALITY ASSURANCE

- A. NFPA - National Electrical Code
- B. Underwriters Laboratory
- C. Basketball scoreboard shall be ETL listed, and be remotely operated via two-wire shielded cable from control point(s). Scoreboard shall display the following information: minutes, seconds and score for two teams as well as Period. Bonus and Double Bonus indicators for each team with Possession indicator on the top section; Team Fouls for two teams and Personal Fouls with Player Number alternating as a Time Advantage clock on the bottom section and side mount statistics display showing player stats
- D. Provide with changeable captions for volleyball and wrestling on the bottom selection.
- E. Game Clock shall have a lit colon or decimal to indicate display of either minutes and seconds or seconds and tenths of seconds.
- F. Equipment to be solid-state electronic technology.

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Unit to score volleyball, basketball, and wrestling.
- B. Wall mounted unit.
- C. Tenth of a second timing for last 50 seconds.
- D. Control console for each board installed.

2.2 SCOREBOARD

- A. Shall be Daktronics BB-2153 and two SD-2103/SD-3103 side mount player fouls and points, and the ALL Sport 5000 controller or approved equal by Nevco or Fair Play to this specification. Provide one (1) unit of this model in the gym.
- B. Overall cabinet size shall be 6 feet in height by 8 feet in length by 6 inches in depth including mounting brackets and constructed of aluminum. Cabinet color shall be as

selected from manufacturers standard colors with selected appropriate trim colors. Cabinet to be shipped assembled and constructed for wall mounting. Approximate weight shall be 101 lbs.

- C. Display digit shall be made up of seven bar-type segments evenly illuminated by epoxy encapsulated LEDs. Digits shall be colored amber for game clock; red and green for other information and protected by an acrylic faceplate. Digit colors shall be determined exclusively by LED light to maximize color saturation. Non-illuminated areas on faceplate shall be screened with black, non-reflective paint to provide maximum contrast.
- D. Digit height to be 12 inches for game clock and team scores and 10 inches for other display information. Game clock shall have a display capacity up to "99:59", team scores to "199", period to "9", personal fouls to "9", player number (or Time Advantage Clock) to "99". Bonus or Double Bonus shall be indicated by two arrows for each team.
- E. Captions shall be adhesive backed white vinyl permanently attached to the cabinet as follows: Home and Visitor 6 inches high; Bonus, Period, Fouls and Player 4 inches high and Possession 3 inches high. Changeable captions for volleyball and wrestling shall be the same vinyl on aluminum plaques and shall be 4 inches high.
- F. Electronics to be packaged in a low voltage, plug-in-processor.
- G. Power to be 120 watts maximum 120 VAC, 60 Hz.
- H. Provide a electronic horn rated at 100dB @ 10'0".

2.3 CONTROL

- A. Shall be All Sport 5000 with carrying case.
- B. Furnished with Hand switch for use when Time Advantage Clock is utilized.

2.4 WIRELESS CONTROL CABLE

- A. Control shall be via Wireless communications.

2.5 WARRANTY

- A. Warranty shall be for 5 years

2.6 ADDITIONAL EQUIPMENT

- A. Provide one duplicate Control units allowing independent operation of a two scoreboard system and providing a backup unit.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide console control outlet in spectator bleachers.
- B. Install scoreboards in accordance with manufacturers instructions and recommendations.

END OF SECTION 264315

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SECTION 265100-INTERIOR LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions, Division 00 and Division 01, apply to this section.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. Underwriter's Laboratory.
- B. NFPA 70 – National Electric Code.
- C. Fluorescent fixtures UL 1570.
- D. Track lighting UL 1574.
- E. Exit signs UL 924.
- F. ANSI C82.1 - Ballasts for Fluorescent Lamps - Specifications.
- G. LED
 - 1. Lighting fixtures shall be of specification grade and listed or labeled by Underwriters Laboratories (UL) or an approved Nationally Recognized Testing Laboratory (NRTL).
 - 2. LED fixtures shall comply with the following:
 - a. UL Standard 8750 "Light Emitting Diode Equipment for use in Lighting Products", IES Standard LM-79 "Electrical and Photometric Measurements of Solid-State Lighting Products", IES Standard LM-80 "Measuring Lumen Maintenance of LED Light Sources", and IES Standard TM-21 "Projecting Long Term Lumen Maintenance of LED Light Sources".
 - b. ANSI C78.377 "Specifications for the Chromaticity of Solid State Lighting Products" with LEDs binned within a maximum five-step MacAdam Ellipse to ensure color consistency amongst luminaires of the same type.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.
- C. Product Data: Submit dimensions, ratings, and performance data.
 - 1. **For each lighting fixture type, the ballast/driver and the lamp must be submitted.**

- D. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.6 MAINTENANCE MATERIALS

- A. Refer to Division 1 requirements.
- B. Furnish one of each plastic lens type.
- C. Furnish one replacement lamps for each lamp installed.
- D. Furnish one of each ballast type.

PART 2 PRODUCTS

2.1 INTERIOR LUMINAIRES

- A. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.
- B. Refer to Section 016000 - Product Requirements for product options.

2.2 ACCEPTABLE MANUFACTURERS

- A. Cooper Industries.
- B. Hubbell.
- C. Daybrite.
- D. Williams.
- E. Lithonia
- F. Holophane.

2.3 LED DRIVERS

- A. Manufacturers:
 - 1. General Electric Co.
 - 2. Philips
 - 3. Sylvania.

2.4 EXIT SIGNS

- A. Type
 - 1. Cast aluminum construction.
 - 2. Color by design professional.
 - 3. LED lamp type.
 - 4. Wireguards as required.
 - 5. Red lettering.
 - 6. Directional Chevrons
- B. Manufacturers
 - 1. Surelites
 - 2. Lithonia
 - 3. Dual Lite

2.5 LED

- A. Recessed lighting fixtures shall be thermally protected.
- B. LED fixtures shall be modular and allow for separate replacement of LED lamps and drivers.
- C. End user must be able to service/replace LED lamps and drivers from the room side.
- D. LED drivers shall be electronic type, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15, and comply with NEMA SSL 1 “Electronic Drivers for LED Devices, Arrays, or Systems”. LED drivers shall have a sound rating of “A”, have a minimum efficiency of 85% and be rated for a THD of less than 20 percent of all input voltages.
- E. Dimmable LED drivers shall be 0-10V type. (unless noted different on fixture schedule) Dimmable LED drivers shall be capable of dimming without LED strobing or flicker across their full dimming range.
- F. For non-LED lighting fixtures and components, provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.
- G. For LED fixtures, lamps, drivers, and components, provide a complete warranty for parts and labor for a minimum of five years from the date of Substantial Completion.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.
- B. Support luminaires larger than 2 x 4 foot size independent of ceiling framing.
- C. Locate recessed ceiling luminaires as indicated on Drawings.

- D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- E. Exposed Grid Ceilings: Support surface-mounted luminaires on grid ceiling directly from building structure.
- F. Install recessed luminaires to permit removal from below.
- G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- H. Install clips to secure recessed grid-supported luminaires in place.
- I. Install wall-mounted luminaires at height as indicated on Drawings or as scheduled.
- J. Install accessories furnished with each luminaire.
- K. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- L. Install specified lamps in each luminaire.
- M. Ground and bond interior luminaires in accordance with Section 260500.
- N. Chain hang troffer type fixtures from structural steel independent of grid or attach fixtures to grid with clips and grid support at each corner of grid.

3.2 FIELD QUALITY CONTROL

- A. Refer to Division 1 requirements.
- B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

- A. Refer to Division 1 requirements.
- B. Aim and adjust luminaires as indicated on architectural Drawings.

3.4 CLEANING

- A. Remove dirt and debris from enclosures.
- B. Clean photometric control surfaces as recommended by manufacturer.
- C. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

- A. Refer to Division 1 requirements.

- B. Relamp luminaires having failed lamps at Substantial Completion.

3.6 LAMPS

- A. 10% of all lamp types and LED light engines types.

3.7 ACCESSORIES

- A. Suspended fixture support components include stem, rod and hook hangers.
- B. Fixture support poles, mast arms and brackets shall be sized appropriately for the EPA of the fixture.

3.8 SCHEDULES

- A. See drawings.

END OF SECTION 265100

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SECTION 265120 – LIGHTING CONTROL PANELS

PART 1 GENERAL

1.1 INTRODUCTION

- A. The work covered in this section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this section with the trades covered in other sections of the specification to provide a complete and operable system.

1.2 SYSTEM DESCRIPTION

- A. Extent of lighting control system work is indicated by drawings and by the requirements of this section. It is the intent of this section to provide an integrated, energy saving lighting control system including Lighting Control Panels, Occupancy Sensors from a single supplier. Contractor is responsible for confirming that the panels and sensors interoperate as a single system.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Comply with NEC, NEMA, and FCC Emission requirements for Class A applications.
- C. UL Approvals: Relay panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Configured to order or custom relay panels shall be UL Listed under UL 508, Industrial Control Panels.

1.4 SUBMITTALS

- A. Submit manufacturer's data on lighting control system and components including shop drawings, detailed point to point wiring diagrams, **and floor plans showing** occupancy sensor locations. Provide typical mounting details for occupancy sensors for this application.

1.5 MANUFACTURERS

- A. This specification is based on products from Watt Stopper/Legrand, Santa Clara, CA. Any other system wishing to be considered must submit descriptive information 10 days prior to bid. Prior approval does not guarantee final approval by the electrical engineer. The contractor shall be completely responsible for providing a system meeting this specification in its entirety. All deviations from this specification must be listed and individually signed off by the consultant. Other Approved Manufactures are LC&D, Hubbell and Lutron.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL PANELS

- A. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
- B. Enclosure/Tub shall be NEMA 1 as indicated on the plans, sized to accept an interior with 1-8 relays, 1-24 relays and six (6) four pole contactors, or 1-48 relays with six (6) four pole contactors.
- C. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
- D. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (class 1) wiring from low voltage (class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:
- E. Provision for one or two optional control and automation cards.
- F. Removable, plug-in terminal blocks with screw less connections for all low voltage terminations.
- G. Individual terminal block, override push button, and LED status light for each relay
- H. Switch inputs associated with each relay and group channel shall support two or three wire, momentary or maintained contact switches or 24VDC input from occupancy sensors.
- I. Isolated contacts within each relay shall provide true relay state to the electronics. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems.
- J. Automatic sequenced operation of relays reduces impact on the electrical distribution system when large loads are controlled simultaneously.
- K. Group, channel, and pattern control of relays shall be provided through a simple button-press interface within the panel. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override push buttons and LED displays.
- L. Relay group status for each channel shall be provided through bi-color operation of the LED indicators. Solid red indicates that all relays in the group are on, solid green indicates that the group is in a mixed state, and blinking green indicates that the relays have blink warned and are currently timing out.
- M. Each relay and channel terminal block shall provide a 24V pilot light signal. It shall be possible to configure the system for support for any Class 2 pilot light voltage with the use of an auxiliary power supply.
- N. Single pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
 - 1. Electrical:

- a. 30 amp ballast at 277V
- b. 20 amp tungsten at 120V
- c. 1.5 HP motor at 120V

2. Mechanical:

- a. Individually replaceable, ½" KO mounting with removable Class 2 wire harness
- b. Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel
- c. Dual line and load terminals each support two #14 – #12 solid or stranded conductors
- b. Tested to 300,000 mechanical on/off cycles
- c. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
- d. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

P. Provide an automation card

2.2 DIGITAL NETWORK CLOCK

- A. The lighting control system shall include a digital clock module capable of system wide automation of the lighting control on a scheduled basis. The clock shall provide capability for independent schedules for each of the eight system wide channel groups.
- B. The clock shall support all of the energy saving features required of ASHRAE 90.1 - 2001, IECC 2003, as well as all state and local energy codes.
- C. The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and EEPROM for program retention. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
- D. The clock shall operate on a basis of unique pre-configured control scenarios. Scenarios shall include:
 - a. Scheduled ON / OFF
 - b. Manual ON / Scheduled OFF
 - c. Manual ON / Auto Sweep OFF (for AS-100 Switches)
 - d. Astro ON / OFF (or Photo ON / OFF)
 - e. Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
- E. The clock shall include system diagnostic functions to identify and verify communication with intelligent field devices anywhere on the network dataline,
- F. The clock module shall function as a dataline switch programming tool and allow the assignment of relays and channel groups to dataline switch buttons.

- G. The user interface shall incorporate an 8-line, 22-character per line LCD display and a simple pushbutton interface with on line help feature
- H. The clock module shall employ non volatile memory and shall retain user programming and time for a minimum of 10 years.
- I. Provide DIN rail mounting for the clock programmer in the Class 2 section of the lighting control panels.

2.3 EIGHT CHANNEL DIGITAL PHOTOCONTROL MODULE

- A. Provide a weatherproof Class 2 photocell for measuring exterior light levels. The photocell shall be mounted facing north as indicated on the plans. The photocell shall be connected to a photocontrol module mounted on the DIN rail inside the low voltage section of a lighting control panel and connected to the dataline communications wire.
- B. The photocontrol Module shall integrate seamlessly with either the Network Clock, Automation Appliance, or the BMS Interface Module. The control module shall measure the actual exterior light and display this level in foot candles (fc) on the unit LCD display.
- C. The controller shall have eight individual set point adjustments that are available to the lighting control network over the dataline communications wire.
- D. Features:
 - a. Real time, 2 line LCD display of actual exterior light level up to 200 fc.
 - b. Channel set points and parameters programmed via the Network Clock or BMS Interface Module.
 - c. Choice of OPERATE or TEST modes, with simulated light level for testing.
 - d. Automatic dead band and 5 minute time delay to avoid cycling.

2.4 DIGITAL DATALINE SWITCHES

- A. Intelligent digital switching shall be provided operating on the dual twisted pair communication wire. Switches shall be available in single, dual, quad, or octal (1-button, 2-button, 4-button, or 8-button) designs. The single, dual, and quad devices shall mount in a standard single-gang box, the octal version in a two-gang box.
- B. Each button shall be individually programmable. Programming of buttons shall not require the use of a computer or other programming device. It shall be possible to assign relays or channels to buttons using a simple button press interface. Each button can control any one of the following options:
- C. Any individual relay in any single panel.
- D. Any group of relays in any single panel.
- E. Any group of relays in the system (via network clock, Automation Appliance, or WinControl software package).
- F. For applications that require pattern switching, buttons shall function as a scene control using an ON/OFF/Not Controlled pattern of relays instead of the normal All ON/OFF.
- G. Switches shall be constructed of non-breakable Lexan on all exposed parts and shall include a matching screwless Lexan wall plate.
- H. Individual buttons shall have a removable clear cover to allow standard 9 mm (3/8 inch) labeling tape to be used to identify the controlled loads.

- I. Each switch shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays. LED indications are Red for All ON, Green for Mixed State (some relays in the group ON and others OFF), and No LED for All OFF.
- J. Switch LED pilot lights shall flash green to indicate impending off sweep during the five-minute grace period following blink warning of the lights. Once the button is pressed, the LED will change to Red to acknowledge the occupant's override command to keep lights ON.
- K. Multiple dataline switches programmed to control the same relay or relay group shall indicate the same status automatically.
- L. Each switch shall also include a locator light illuminating the switch for easy location in the dark.
- M. The dual, quad, and octal switches shall all include a single master button that will override all relays controlled by the individual buttons OFF, or Restore them to their original state. Each switch's master button configuration can be altered to perform a Master ON/OFF, OFF Only, or Disabled function if desired.
- N. Switches can be configured to follow a "Cleaning" scenario. This specific scenario shall prevent the cleaners from overriding OFF any relays previously turned ON by an occupant.
- O. Each switch is available in a Key lock override version. Once a key is inserted, the individual buttons will function for five minutes.
- P. Provide professional and logical labeling of each button.
- Q. Gym locations and larger locations shall have 4 button units minimum and all classrooms shall be 4 button minimum.
- R. **The contractor shall provide a complete layout of the system including detailed floorplan drawings, riser diagrams, details, and schedules for approval.**
- S. Provide key lock versions in gyms, corridors, and other locations as directed.

2.5 PARTITION BARRIER

- A. **Provide a barrier to separate the normal power and emergency power wiring and relays in each panel.**

2.6 WIRING

- A. All wiring shall be as recommended by the manufacturer and shall be plenum rated and installed in conduit.

PART 3 EXECUTION

3.1 SUPPORT SERVICES

- A. **System Start Up and Commissioning of each panels and the entire system. Provide multiple visits to the site to commission the panels as they are completed at various times in different phases.**

- B. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all lighting control system components. The startup requirement is intended to verify:
- C. That all occupancy sensors are located, installed, and adjusted as intended by the factory and the contract documents.
- D. The occupancy sensors are operating within the manufacturers specifications.
- E. The sensors and relay panels interact as a complete and operational system to meet the design intent.
- F. Manufacturer to provide a written statement verifying that the system meets the above requirements.
- G. System Training:
 - a. Manufacturer shall provide factory authorized technician to train owner personnel in the operation, programming and maintenance of the lighting control system including all occupancy sensors controls. There shall be a minimum of 16 of owner user training with video taping.
- H. System Programming:
 - a. Manufacturer shall provide system programming including:
 - b. Wiring documentation.
 - c. Switch operation. This shall include meeting and consultations with the owner and design team to fine tune the desired operations of fixtures.
 - d. Telephone overrides.
- I. Operating schedules.

3.2 INSTALLATION

- A. Provide complete installation of the system including all labor, materials, raceways, wiring etc, as directed and as recommended by the manufacturer.

END OF SECTION 265120

SECTION 265600-EXTERIOR LIGHTING**PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes exterior luminaires, poles, and accessories.

1.2 REFERENCES AND QUALITY ASSURANCE

- A. ANSI C82.1 - Ballasts for Fluorescent Lamps-Specifications.
- B. ANSI C82.4 - Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type).
- C. ANSI O5.1 - Specifications and Dimensions for Wood Poles.
- D. NFPA 70
- E. UL 1570 fluorescent fixtures
- F. UL 1572 HID fixtures
- G. UL 1571 incandescent fixtures
- H. UL 1574 Track lighting
- I. UL 924 exit signs
- J. UL 924 emergency lighting

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.
- C. Product Data: Submit dimensions, ratings, and performance data.
- D. Samples: Submit two color chips **3 x 3 inch** in size illustrating luminaire finish color where indicated in luminaire schedule.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.

- B. Store and handle solid wood poles in accordance with ANSI O5.1.

1.6 COORDINATION

- A. Section 013300 – Submittals.
- B. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.7 MAINTENANCE MATERIALS

- A. Refer to Division 1 requirements.
- B. Furnish two of each lamp installed.
- C. Furnish two gallons of touch-up paint for each different painted finish and color.
- D. Furnish two ballasts of each lamp type installed.

PART 2 PRODUCTS

2.1 LUMINARIES

- A. Product Description: Complete exterior luminaire assemblies, with features, options, and accessories as scheduled.
- B. Refer to Section 016000 - Product Requirements for product options.
- C. Manufacturers
 - 1. Cooper
 - 2. DayBrite
 - 3. Lithonia
 - 4. Holophane
 - 5. Gardco

2.2 LED DRIVERS

- A. Manufacturers:
 - 1. Cooper Industries Inc.
 - 2. General Electric Co.
 - 3. Sylvania.
 - 4. Advance.

2.3 METAL POLES

- A. Manufacturers:
 - 1. Cooper Industries.
 - 2. Day Brite.
 - 3. Holophone.
 - 4. Lithonia

- B. Material and Finish: Aluminum with silver anodized finish.
- C. Section Shape and Dimensions: Tapered round.
- D. Height: 25 feet or as scheduled.
- E. Base: Bolted.
- F. Accessories:
 - 1. Anchor bolts.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Refer to Division 1 requirements.
- B. Verify foundations are ready to receive fixtures.

3.2 INSTALLATION

- A. Install concrete bases for lighting poles at locations as indicated on Drawings, in accordance with Section 033000. Pole Bases shall be 24 inches high from grade.
- B. Install poles plumb. Install double nuts to adjust plumb. Grout around each base.
- C. Install lamps in each luminaire.
- D. Bond and ground luminaries, metal accessories and metal poles in accordance with Section 260526. Install supplementary grounding electrode at each pole.

3.3 FIELD QUALITY CONTROL

- A. Refer to Division 1 requirements.
- B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- C. Measure illumination levels to verify conformance with performance requirements.
- D. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.4 ADJUSTING

- A. Refer to Division 1 requirements.
- B. Aim and adjust luminaries to provide illumination levels and distribution.

3.5 CLEANING

- A. Clean photometric control surfaces as recommended by manufacturer.
- B. Clean finishes and touch up damage.

3.6 PROTECTION OF FINISHED WORK

- A. Refer to Division 1 requirements. Replace damaged poles and luminaries.
- B. Relamp luminaries having failed lamps at Substantial Completion.

3.7 SCHEDULES

- A. See Light Fixture Schedule.

END OF SECTION 265600

SECTION 270100 - COMMON WORK RESULTS FOR TECHNOLOGY AND COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. This section contains the general requirements that shall be required of any/all Contractors bidding and/or executing any part or parts of these Documents.

B. General Requirements

1. Drawings and Specifications are to be considered as supplementing each other. Work specified but not shown, or shown but not specified, shall be performed or furnished as though mentioned in both the Specifications and the Drawings.
2. The Contractor shall provide all Technology Systems and Cabling Infrastructure as indicated in the Documents. Should there be any requirements for further subdivision of scope of work, such subdivisions shall be indicated by either notated clarification or schedule on the Drawings.
3. The Contractor shall coordinate with all other trades to assure the execution of these Documents and their intent. Any equipment or devices either not installed, or installed in a fashion other than that indicated by the intent of these Documents, shall be Provided or re-worked so as to become compliant with the intent of these Documents. The financial responsibility for such additional Work or Materials shall be borne solely by the Contractor.
4. The Contractor shall provide all Work required to deliver to the Owner all systems and/or infrastructure, complete and functional, as indicated in these Documents.
5. All Drawings and Specifications shall be considered as complementary to each other. The Contractor shall provide all cabling, equipment, devices, etc. required to fulfill the intent of the design. Items specified, but not drawn, or drawn but not specified shall be considered as being provided as if they had been explicitly called out in both.

C. Trade Coordination

1. Coordination with all other trades/sub-contractors shall be provided to the maximum extent required to assure compliance with the complete design intent of the entire design team. Coordination drawings are required of the Prime HVAC contractor. Any/all sub-contractors and sub-subcontractors shall provide all required resources and assistance as may be required to facilitate accurate coordination and coordination drawings. Such efforts and resources on the part of the Division 27 and Division 28 Contractors, Sub-contractors and Sub-sub-contractors shall be deemed within the base scope and shall be provided at no additional cost to the Owner, or Owner's Representatives. Refer to coordination

requirements as required under the Mechanical, Electrical and General Trades Specifications.

D. Products Supplied but not installed by the Contractor

1. The Contractor shall coordinate the delivery of items that must be installed by other trades so as to assure timely delivery.
2. The Contractor shall verify lead times of all items required under this heading. Should the delivery of such items be delayed due to the Contractor's efforts, or lack thereof, the Contractor shall bear the burden of compensation to all related trades and for any expedited handling, so as to regain any loss incurred by the project schedule.

E. Products Installed but not Supplied by the Contractor

1. It shall be incumbent upon the Contractor to verify the exact requirements of any system, device, equipment, or Materials supplied to them for installation by others. Any deviations between the Contract Documents and these requirements shall be brought to the immediate attention of the Engineer, and to the other trades as necessary.

F. Devices, equipment, or other infrastructure installed by other contractors in support of this Contractors efforts

1. It shall be the responsibility of this Contractor, and sub-Contractors and sub-sub-Contractors to coordinate with the other contractors on the project who shall be providing items such as rough in box and conduit to facilitate this Contractor's systems and device to verify the appropriateness and location of these items.
2. This Contractor shall provide any necessary guidance as to the correctness of the information being used by these other contractors. Any item(s) either being provided out of Specification, in the wrong location, or inappropriate for the application shall be:
 - a. intervened upon immediately,
 - b. communicated to the CM/GC for resolution in writing,
 - c. communicated to the Engineer for resolution.
3. Should the Contractor fail to coordinate, intervene and communicate the issue(s) to the aforementioned parties, it shall be the responsibility of this Contractor to correct such issues at the sole burden of this Contractor.
4. Note: It is understood that this Contractor cannot and shall not be held accountable for items of this nature, prior to this Contractor's authorized involvement in this project.

1.2 RELATED SECTIONS

- A. Section 270200 – Communications Demolition
- B. Section 270524 – Communications Firestopping
- C. Section 270526 – Grounding and Bonding for Communications Systems

- D. Section 270528 – Pathways for Communications Systems
- E. Section 271100 – Communications Equipment Rooms Fittings
- F. Section 271323 – Communications Optical Fiber Backbone Cabling
- G. Section 271513 – Communications Copper Horizontal Cabling
- H. Section 275113 – Public Address Systems
- I. Section 275123 – Intercom Systems
- J. Section 275313 – Wireless GPS Clock Systems
- K. Section 280513 – Conductors and Cables for Electronic Safety and Security
- L. Section 281300 – Access Control System
- M. Section 281600 – Intrusion Detection System
- N. Section 282300 – Video Surveillance
- O. Division 1 – General Requirements
- P. Division 2 – Earthwork
- Q. Division 7 – Firestopping
- R. Division 9 – Finish Painting
- S. Division 11 – Equipment
- T. Division 14 – Conveying Systems
- U. Division 25 – Mechanical
- V. Division 26 – Electrical

1.3 REFERENCES

- A. The provisions of these specifications along with all Drawings, Alternates, Addenda, Bulletins, RFP's, or other related documents shall be considered an integral part of the scope of work for this/these Contractor(s). These Documents along with the Division 1 and other related division's documentation shall be examined by this Contractor and any/all sub-contractors prior to submission of their bid.

1.4 DEFINITIONS

- A. The Definitions contained within shall be the basis of the definitions required for this Scope of Work. Additional definitions shall be found in any given Specification Section that pertains to that Specification Section.

B. Definitions:

1. Acceptance – The term “Acceptance” shall mean the Owner’s notification to the Contractor that the work, as defined herein, has been Furnished and Installed in accordance with the Contract Documents. Furthermore, the Contractor has completed, documented, and submitted all requisite documentation both to the Owner and any other required Company or Organization to achieve all warranties, certifications, or other related documents.
2. Construction Manager (CM) – The term “Construction Manager” shall mean the company, including staff, responsible for the construction and commissioning of the new and/or renovated building(s) as defined within the scope of this project.
3. Contract Documents – The term “Contract Documents” shall mean all Drawings, Specifications or other related documents representing the scope of the project. Such Documents shall include, but not be limited to, sketches, addenda, change orders, proposal requests and architectural supplemental instructions released under the scope of this project.
4. Contractor – The term “Contractor” shall refer to the Technology Contractor and shall include all of the Technology Contractor’s sub-contractors, and their sub-contractors. The term Contractor shall indicate the Electrical Contractor for those items that are described as being furnished and/or installed by the Electrical Contractor in the “Scope Clarifications” on the Drawings.
5. Drawings – All graphic and/or pictorial portions of the Contract Documents which are used to represent the design and scope of the project. These include, but are not limited to, plans, details, sections, elevations, diagrams, and schematics
6. Electrical Contractor (EC) – The term “Electrical Contractor” shall mean the contractor or contractors responsible for providing the scope of work described in the electrical drawings and specifications.
7. Furnish – The term “Furnish” shall mean to supply and deliver to the project job site, ready for unloading, unpacking, assembly, installation, and other related work.
8. Install – The term “Install” shall mean all work related to the unloading, unpacking, placing, anchoring, bracing, cabling and other related work.
9. Low Voltage Equipment Room (LVER) – The term “Low Voltage Equipment Room” shall mean the space containing the equipment and enclosures supporting those low voltage systems not accounted for in the telecommunications system. In some cases, the LVER may be co-located with the Telecommunications Room.
10. Materials – The term “Materials” shall mean all products, supplies, and components, provided by the Contractor to be incorporated into work as described within these Documents.
11. Owner – The term “Owner” shall mean the company or organization for whom the work is being performed and shall include any/all duly appointed representatives of the company or organization.

12. Project Manager – The term “Project Manager” shall mean the person from either the Owner or Contractor who shall be the sole point of contact.
13. Provide – The term “Provide” shall mean to furnish and install.
14. Specifications – The term “Specifications” shall mean that portion of the Contract Documents that consists of the written requirements for all Materials, equipment, systems, installation standards, means and methods for the Work whose scope is defined herein.
15. Sub-Contractor – The term “Subcontractor” shall mean any person, persons, organization or companies providing the Contractor with any portion of the Work required by the Scope of these Documents.
16. Telecommunications Room (TR) – The term “Telecommunications Room” shall mean the space containing the equipment and enclosures supporting the Telecommunications Systems. In some cases, the Telecommunications Room may be co-located with the Low Voltage Equipment Room.
17. Technology Contractor – The term “Technology Contractor” shall mean the Contractor responsible for providing the Work required to provide the entire scope of work described in these Contract Documents. Such scope does not include those portions of the Work that is indicated within these Documents as being provided by the Electrical Contractor.
18. Work – the term “Work” shall mean all contractual obligations including, but not limited to, Project Management, Materials, labor, equipment, testing and documentation required by these Documents. Such obligations may include all or any part of the scope described herein.

1.5 ACTION SUBMITTALS

A. General:

1. It is the assumption of the Engineer that items not provided with any given submission shall be submitted in a later time. Until such time as missing or incomplete submission is otherwise resolved, any/all related materials shall be considered as Not Approved.
2. Any indication of items not required on the submission shall be construed as being done as a convenience of the Contractor and shall not act as a modification to the Design Intent.
3. Any variations or deviations from the Specifications and Drawings, unless approved in writing by the Engineer, is the sole responsibility of the Contractor. The Contractor shall clearly indicate all variations or deviations on any/all submissions. The Contractor shall further notify the Engineer of the variation or deviation in writing at the time of the submission.
4. The Contractor, by virtue of these specifications, understands and acknowledges that any changes that might occur during the any of the submittal phases shall not be construed to be a change order, and does not authorize the Contractor to pursue additional compensation. The submittals shall be used to express the understanding of the scope of the contract to the Engineer.

5. The Contractor shall refer to the other Specification Sections within this Document for additional requirements with regard to submittals and submittal processes. The Contractor shall fully comply with those requirements. Should any requirement listed in any subsequent section be in conflict with these requirements, the Contractor shall notify the Engineer in writing within the RFI window providing as much time as possible for an accurate response. Should the Contractor fail to provide such notification, the Owner/Engineer reserves the right to require either or both of the submission requirements to be met.

B. Product Data:

1. As required.
2. Refer to each Division 27 and/or 28 Specification Section for system specific requirements.
3. Product data sheets shall be reviewed for general compliance with the Contract Documents, not for dimension accuracy, quantities, etc. Once the submittals have been approved and returned to the Contractor, they shall be used for procurement of the Materials required. It is the responsibility of the Contractor to assure accurate procurement. Submittal review shall not be used to alleviate the Contractor from responsibility for errors and omissions during the procurement of these Materials.
4. Product information that is required under the various sections of these Documents shall include all pertinent data required to ascertain acceptability of the product. This information shall include, but is not limited to, exact dimensions, color, model number, and performance criteria.
5. Product data sheet utilized containing multiple products shall clearly delineate the product information to be reviewed.
6. Separate product data sheets shall be used for each product submission. Use of a single product data sheet for more than one product is not acceptable.
7. All product information shall bear the Contractor's approval stamp.
8. Any submission not bearing the approval stamp of the Contractor, or not being clearly indicative or containing multiple products on a single product data sheet shall be returned without processing.
9. Contractor is advised NOT to proceed with procurement or installation without reviewed and approved Product Data Submittals. Should the Contractor proceed, Contractor acknowledges that they do so at their own risk. Furthermore, Contractor may be required to remove, replace and/or rework entirety with no additional compensation.

C. Shop Drawings:

1. Reviewed and stamped by Project Manager.
2. All Shop Drawings shall bear the Contractor's approval stamp. Any submission not bearing the approval stamp of the Contractor shall be returned without processing.

3. Refer to each Division 27 and/or 28 Specification Section for system specific requirements.
4. Include all system schematic, interconnect or other wiring diagrams complete.
5. Include any/all custom fabricated devices, equipment, cable harnesses, etc. with complete dimensions, finish information, cabling and connectivity, etc.
6. Include any proprietary or custom installation requirements for review. Such submissions are for review only, and do not require approval by the Engineer as it is a specific requirement of these specifications that all Materials, equipment and devices be installed per the manufacturer's suggested installation procedures.
7. Where appropriate, all Shop Drawings shall be drawn to scale with all scale information clearly indicated on the submission.
8. Shop Drawings shall be reviewed for general compliance with the Contract Documents, not for accuracy of design or quantity of device. Once the submittals have been approved and returned to the Contractor, they shall be used for installation. It is the responsibility of the Contractor to assure accurate and complete design. Submittal review shall not be used to alleviate the Contractor from responsibility for errors and omissions during the design or installation of the Scope of Work.
9. All Shop Drawings shall contain a complete title block with clear indication of system(s) represented and Contractor providing submission.
10. Contractor is advised NOT to proceed with procurement or installation without reviewed and approved Shop Drawing Submittals. Should the Contractor proceed, Contractor acknowledges that they do so at their own risk. Furthermore, Contractor may be required to remove, replace and/or rework entirety with no additional compensation.

D. Samples and Mockups:

1. As required.
2. Refer to each Division 27 and/or 28 Specification Section for system specific requirements.
3. The Owner/Engineer reserves the right to require samples of any/all Materials for the purpose of clearly determining acceptability of same. The Engineer shall be free to perform any test destructive or otherwise on any/all Materials submitted.
4. Samples, where not custom assemblies, shall be off the shelf product obtained from distribution, the source of which may be randomly selected by the Engineer. No product shall come directly from manufacturing without the express written consent of the Engineer.
5. Mockups shall be constructed in the field under actual field conditions, unless explicitly required otherwise by the Engineer in writing. Such mockups shall be made available to the Engineer for review and comment either in the field or at the Engineer's office, at the Engineer's discretion. Such comments shall be utilized to review and potentially modify the design as necessary, prior to installation.

6. Submit all samples required in a timely fashion, based on request from Engineer, or as specified herein. All samples must be submitted prior to installation, unless specifically authorized in writing. The Contractor shall provide the sample with sufficient time for examination and review without impacting the production schedule.
7. All samples submitted to the Engineer for review and/or approval shall become the property of the Engineer without the expectation of return. Should a cost be associated with a sample, it shall be the responsibility of the Contractor to bear the cost. At the conclusion of said examination and review the Engineer reserves the right to discard or keep any sample or return the sample to the Contractor for disposal.

1.6 QUALITY ASSURANCE

A. Project Management

1. The Prime Contractor for this Division shall provide a Project Manager who, in addition to the requirements listed elsewhere in these Documents shall possess a current RCDD. Said certification shall remain current from the time of the submission of the copy during bidding and bid review through the project close out. This requirement shall not be fulfilled by a sub-contractor, sub-sub-contractor, vendor, manufacturer or manufacturer's rep. The RCDD must be a full time regular employee of the Contractor, and must be on the payroll at the time of the submittal of the bid form.
2. Should the scope of this either not require any structured cabling, or have multiple contracts let as a function of the method of bidding, each Contractor shall provide a person whose role shall fulfill that of the Project Manager described herein. For additional requirements of these persons, refer to the various section of the Specification.
3. The Contractor shall provide a Project Manager whose responsibility is the accurate and timely execution of this project. The PM shall have a minimum of five (5) years experience, of this five (5) years experience, a minimum of two (2) years experience shall be as a field installation technician, and a minimum of two (2) years shall be the management of projects and personnel consistent with this project.
4. The Project Manager shall be assigned to the project from the time of Contract Award until Project Close Out, including any time that may be required to resolve final punch list items.
5. The PM shall be the sole point of contact by the Engineer, Owner, CM, or other related personnel, for the duration of the project.
6. The PM shall be responsible for all reports and accountability of the Contractor to be supplied to the Engineer, Owner, CM or other related personnel.
7. Should the PM fail to execute his responsibilities as outlined herein, the Engineer, or Owner, shall retain the right to require the Contractor to provide a replacement for the PM. This replacement shall be approved in advance by the Engineer.
8. Should the Contractor not be able to provide a suitable PM, or if required, a replacement PM, the Owner shall retain the right to terminate the Contract Agreement with the Contractor.

B. Subcontractors

1. Where necessary, the Contractor may utilize qualified, and as applicable, certified Subcontractors. The Contractor shall prove the qualifications of the Subcontractor to the Owner and Engineer prior to executing any agreements either written or verbal. Such methods of proof shall be at the discretion of the Owner, and may include, but not be limited to, submissions of the same documentation as listed under the Contractor's Qualifications.
2. The Owner reserves the right for any reason to reject any Subcontractor. The Contractor shall then be required to provide an acceptable replacement Subcontractor. The qualifications of said replacement shall also be subject to verification prior to any agreement, written or verbal.
3. The Owner reserves the right to have a Subcontractor removed from the Project. Should removal of a Subcontractor be required, any replacement shall be subject to the aforementioned qualifications verification.
4. All Subcontractors must exist to provide viable outcome to the project. No Subcontractor may serve the sole purpose of providing Project Management, or providing a necessary certification only, e.g. A Project Manager shall not be Subcontractor may not serve the sole role of providing an RCDD to fulfill certification requirements.
5. No personnel employed by distributors, manufacturers representatives or other distribution channel organizations may be utilized for the provision of any required certifications, whether compensated financially or otherwise, e.g. A manufacturers Technical Support staff member may not be utilized to supply a required RCDD.

1.7 INFORMATIONAL SUBMITTALS:

- A. Qualification Data: **Required with bid response.** As defined within this Section and all Division 27 and 28 Sections.

NOTE: any/all qualification materials shall be in effect prior to bid submission. All qualifications requirements shall be maintained throughout the duration of the Contract. The Owner reserves the right examine and investigate the legitimacy of the qualifications materials and disqualify any bidder or bidder's sub-contractor or sub-sub-contractor based on the unacceptable status of these requirements. Should any Contractor, sub-Contractor or sub-sub-Contractor violate any of the qualifications criteria during the duration of the Contract, the Owner reserves the right to require replacement with a qualified replacement at no penalty or additional cost to the Owner.

B. Other Data and Information:

1. As required.
2. Refer to each Division 27 and/or 28 Specification Section for system specific requirements.

1.8 CLOSE OUT SUBMITTALS

- A. Operations and Maintenance Manuals

B. As-Built Documentation:

1. Provide electronic copies of all field markups scanned into Portable Document File (pdf) format.
2. Provide electronic copies of all plans, diagrams, elevations, etc. created in the same format as the original design documents completed. Files shall be unlocked, without password, and editable by the Owner in a valid copy of the original software.

C. Test Results:

1. As required.
2. Refer to each Division 27 and/or 28 Specification Section for system specific requirements.

D. Maintenance Data:

1. As required.
2. Refer to each Division 27 and/or 28 Specification Section for system specific requirements.

E. Maintenance Materials and Attic Stock

1. The Contractor shall supply to the Owner, at the time of demonstration and training, all spare parts as required within these Documents. In addition to those items required elsewhere in these Documents, the Contractor shall provide a minimum of 10%, but not less than one complete item, of all expendable and/or replaceable items utilized for installation of the systems and equipment required in these Documents, such as fuses and filters.
2. The Contractor shall provide all spare parts in a means of containment that shall provide for an organized and protected storage of such Materials in close proximity to where they would be required.
3. The Contractor shall provide a complete and comprehensive list of all maintenance materials and attic stock supplied.

F. Warranty Statements and Submissions:

1. As required.
2. Refer to each Division 27 and/or 28 Specification Section for system specific requirements.

G. Failure to provide required Close Out Submissions may impede the final acceptance by the Owner, delay commencement dates for warranty coverages and delay final payments and retention release.

1.9 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall furnish four copies of Operations and Maintenance (O&M) Manuals prior to application for final payment.

- B. The O&M Manuals shall be bound individually in a three ring binder that shall have sufficient space so as to allow the Owner to add materials to these.
- C. The O&M Manual shall be identified and organized as follows:
1. Cover/Outside of Binder
 - a. The cover shall consist of a plastic sheeting installed by the binder manufacturer that shall allow 8.5" x 11" sheets to be installed in both the front and back of the binder, as well as the width of the spine by 11" on the spine of the binder.
 - b. The front of the binder shall contain the following information laser printed on a minimum of 32lb. stock paper. This information shall be centered horizontally on each line. All names shall be in a font twice the size of the subsequent information. The information shall be as follows:
 - 1) The Project name, address, phone number and logo of the Owner
 - 2) The date of Owner's acceptance
 - 3) The Engineer's name, address, phone number and logo
 - 4) The Contractor's name, address, phone number and logo
 - c. The back of the binder shall contain the name of the prime contractor in Arial 10 pt. centered along the bottom of the page.
 - d. The Spine of the binder shall contain the words "Technology Systems Operations and Maintenance Manual". Should the manual require more than one binder, each binder shall be labeled with "Volume (number) of (number)". All printing shall be large enough for easy recognition, and a minimum of ½".
 2. Inside
 - a. The inside of the binder(s) shall be divided into an index and one section for each system and/or specification section.
 - b. Each section and subsection shall be separated by a manufactured tabbed divider sheet which clearly indicates the name or number of the section on the tab. Section tabs shall be easily discernable from subsection tabs, and shall have a more prevalent visual appearance than subsections.
 - c. Where multiple volumes are required, the index shall be organized as follows:
 - 1) The complete index shall be included in each volume.
 - 2) The index shall be organized so as to group the contents of each volume.
 - 3) Each group shall be clearly indicative of the volume in which it is contained.
 - 4) The header of the index shall clearly indicate the volume in which you are currently viewing the index.
 - d. Each section shall include subsections that shall be logically organized, and, where applicable, shall include but not be limited to the following information:
 - 1) A copy of the manufacturer's warranty, including effective dates of commencement and completion of warranty coverage, and contact information for the manufacturer(s)
 - 2) The system's project specific installation diagrams, both electronic and hard copies, including all field modifications occurring during the installation process, i.e. record drawings for that system.
 - 3) Manufacturer's Data Sheets
 - 4) Manufacturer's Installation, Operations and Maintenance Instructions
 - 5) Suggested Spare Parts List, and project specific maintenance requirements
 - 6) Startup, commissioning and field test results electronic copies, both electronic and hard copies

Note: All electronic documentation shall be recorded onto CR-ROM in a format either readily accessible to Microsoft Office, AutoCAD or Adobe Acrobat Reader, or through an application specific viewing software for the testing device utilized for the testing of the system or infrastructure. The Contractor shall provide either on the CD or on a standalone CD and applications specific reading software that may be required at no additional cost to the Owner. Should said software be licensed on a per seat basis, the Contractor shall provide a minimum of a four seat license, on for each copy of the manual.

1.10 QUALITY ASSURANCE

A. Qualifications

1. The Contractor shall be fully qualified, trained and certified to perform the Work indicated on these drawings.
2. The Contractor shall have been active in the bidding, being awarded and executing work consistent with that which is indicated on these Documents for a minimum of five (5) years. Any deviation from this requirement is at the sole discretion of the Engineer. Requests for such deviations shall be submitted in writing a minimum of two weeks prior to the bid submission. Approval of such requests shall be in writing from the Engineer. A copy of this approval shall be submitted with the bid.
3. The Contractor shall have completed a minimum of three projects of like scope and complexity within the past two years. Project names and references, including, but not limited to, contact name and phone numbers of personnel with whom the Contractor has directly interacted shall be provided to the Engineer upon request. The Engineer reserved the right to contact any/all references provided to verify their accuracy and legitimacy. Any negative references shall be duly noted and considered when determining the Contractors qualifications or lack thereof.
4. The Contractor shall maintain an installation staff whose sole function is that of installing the systems or infrastructure indicated on the drawings. The Contractor shall not utilize any installation personnel that have been provided by any temporary staffing or placement agency. Only personnel qualified and experienced in the installation of the system or infrastructure for which they are installing, may perform the installation work.
5. The Contractor shall not utilize any apprentice or trainee personnel for the installation or termination of cabling or equipment unless under the direct supervision of a qualified technician.
6. The Contractor shall maintain a local presence, within fifty miles, which shall include, but not be limited to, warehousing of Materials, an office with support personnel, Project Management personnel, and a service department having a stock of replacement parts consistent with, at a minimum, the spare parts required by this project.
7. The Contractor shall be fully insured and bondable as referenced within these Documents.
8. The Contractor shall have staff with the ability, if required, to be assigned solely to this project for its duration.

9. The Contractor shall provide a list of all personnel indicated as being required to be assigned to this project during the process of bid submission and review. Should the Contractor fail to provide the list of personnel during this time period, the Owner reserves the right to consider the Contractor as being not fully responsive.

B. Regulatory Requirements

1. Incumbent on the execution of these Documents is the requirement that all work adhere to and be compliant with all codes and regulations. These codes and regulations include, but are not limited to the latest revisions (or the applicable revisions) of:
 - a. FCC Part 15 – Radiation Limits
 - b. FCC Part 22 – Public Mobile Service
 - c. FCC Part 68 – Connection of Terminal Equipment to the Telephone Network
 - d. FCC Part 76 – Cable Television Service
 - e. NESC – The National Electric Safety Code
 - f. NFPA 70 – The National Electric Code
 - g. NFPA-70E – Standard for Electrical Safety Requirements for Employee Workplaces
 - h. NFPA-72 – National Fire Alarm Code
 - i. NFPA-75 – Protection of Electronic Computer Data Processing Equipment
 - j. NFPA-101 – Life Safety Code
 - k. NFPA-297 – Guide on Principles and Practices for Communications Systems
 - l. OBC – The Ohio Building Code
2. Consistent with the expectation of quality workmanship executed in a neat and workman like fashion, all installation, labor and materials shall be provided such that they are compliant with the latest revision of the following standards:
 - a. ANSI/TIA/EIA 568 – Commercial Buildings Telecommunications Cabling Standard
 - b. ANSI/TIA/EIA 569 – Commercial Building Standard for Telecommunications Pathways and Spaces
 - c. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Building
 - d. ANSI/TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
 - e. BICSI TDMM – Telecommunications Distribution Methods Manual

Note: The standards, codes and regulations listed above are only a partial listing. Any/all industry standards, codes and regulations that are applicable to the scope of the Work required shall be considered as a specific requirement of this project.
3. The Contractor shall become fully aware of all plenum vs. non-plenum areas, and shall provide the required Materials and labor to fulfill said code requirements.
4. The Contractor shall become fully aware of all fire rated and smoke rated walls, and shall provide the required Materials and labor to fulfill said code requirements.
5. The Contractor shall completely versed in the all applicable codes and shall comply fully with all codes and regulations, including, but not limited to any potential deviations from same due to interpretations by the Authority Having Jurisdiction.

C. Certifications

1. As indicated in the various sections of these Specifications, all Contractors responsible for the provision of any of these systems shall possess certifications acknowledging the expertise of both the Contractor firm and the personnel assigned to the project. Such certifications shall be current, and remain current for the duration of the project. Should any personnel lose the associated certification, the Owner/Engineer reserves the right to require that said personnel be replaced with competent, certified personnel. The Owner/Engineer reserves the right to review, qualify and refuse for any reason, any suggested replacement personnel.
2. As indicated elsewhere in these Documents, all certifications must be submitted to the Engineer for approval AT TIME OF BID FORM SUBMISSION, unless the certified personnel are a member of a sub-contractor or sub-sub contractor. In such cases, the prime Contractor shall submit any required certifications a minimum of two weeks prior to declaration of sub-contractors or sub-sub-contractors. Submissions of certifications of sub-contractors and sub-sub-contractors shall be used as one of the key criteria in determining the qualifications of the sub-contractor and sub-sub-contractor. The Owner/Engineer reserves the right to disqualify a sub-contractor or sub-sub-contractor based on these certification submissions.

D. Pre-installation Meetings

1. The Contractor's Project Manager shall attend pre-installation meetings at which time the Engineer shall review scope and design intent to assure proper execution and provision of the appropriate Materials. Such meetings shall be scheduled with the Engineer and Owner two weeks prior to the notice to proceed, to allow sufficient time for the Contractor and Engineer to determine a mutually agreed upon time and location.

E. Installation Requirements

1. All Contractors responsible for the installation of devices, cabling and equipment for the project shall be required to install all devices, cabling and equipment in a neat and professional manner, including but not limited to, dressing all cabling, mounting all devices and equipment square, routing all cabling consistent with the lines of the building, providing wire management to neatly route cabling, adequately recessing equipment that is to be recessed, and properly attaching devices and equipment to walls or other structure.
2. The final discretion as to compliance with this requirement shall be that of the Engineer and Owner mutually. Any devices, cabling and equipment not found to be installed in this fashion shall be reworked to the mutual satisfaction of the Owner and Engineer at no additional cost to the Owner or Engineer.

1.11 DELIVERY STORAGE AND HANDLING

A. Packing, Shipping and Handling

1. The Contractor shall provide appropriate personnel to perform all packing shipping and handling.
2. The Contractor shall accept full liability for all Materials handled until such equipment and devices have been installed, tested and accepted by the Owner.

B. Storage and Protection

1. All Materials required for the project, but not having sufficient storage space on site, shall be stored at a secured location under the control of the Contractor.
2. Materials being stored on site, shall be secured by the Contractor until such time as they are required in the field.
3. Damage to any of the aforementioned Materials, shall be the financial responsibility, until such time that the Owner has accepted the installation.
4. Any additional security to assure the safety and security of these Materials shall be born by the Contractor at no additional expense by the Owner.

C. Waste Management and Disposal

1. All refuse and debris generated by the Contractor shall be the responsibility of the Contractor to provide appropriate means by which to dispose of such scrap Materials. The Contractor shall provide all required containers and vehicles to dispose of properly, at no additional cost to the Owner.
2. The Contractor shall clean all debris created by the Contractor caused by the process of providing any of the Materials within the Documents, and dispose of the resultant debris in an appropriate fashion.

1.12 PROJECT/SITE CONDITIONS

- A. The Contractor shall visit the Site prior to submission of their bid proposal to familiarize themselves with the existing conditions. Such conditions may affect the scope of work or the effort required to fulfill the intent of the design. Additional compensation due to lack of familiarization with these existing field conditions shall not be acceptable and shall not be honored.

1.13 SEQUENCING

- A. The Contractor shall participate in all meeting necessary to assure the proper execution and sequencing of the installation.

1.14 SCHEDULING

- A. All scheduling shall be coordinated with the master project schedule, and adapted as changes in the master schedule occur. Any deviations from the posted Master Schedule shall be approved by the Owner/Engineer or approved representative.
- B. A copy of the schedule and any subsequent deviations shall be submitted to the Engineer at least once a week.
- C. The Contractor shall derive an initial schedule of completion that shall be the basis of coordination with the CM and the other trades on the project.

- D. Upon execution of an agreement with the Contractor, the Contractor shall schedule a meeting with the CM, and any other required trades to re-work the schedule to be consistent with the expectations of the overall project. It shall be the responsibility of the PM to perform weekly reviews of the schedule with the CM to modify the schedule and subsequent Work requirements and logistics to remain coordinated with the overall effort of the Project. Should the PM be unable to maintain this coordination for reasons of lack of Material availability or other external reason, it shall be the responsibility of the PM to immediately notify the Engineer and Owner, or Owner's approved representative, so that appropriate action may be taken.
- E. The PM shall keep written track of all progress of the project, including, but not limited to, Material orders and procurement, mobilization, staffing requirements and installation status. This progress shall be tabulated and submitted to the Engineer on a weekly basis. The format of this table shall be submitted to the Engineer for approval, and shall be in Excel 2000, or greater, format.
- F. Should Sub-Contractors be utilized on the project, their information shall be incorporated both in the scheduling projects and status reports.
- G. Any changes to the schedule must be mutually agreed upon and shall be submitted in writing to the Engineer immediately upon the identification of the need to make said changes. Once the schedule has been changed any future adjustments, including those which would re-establish the original schedule, shall also be submitted in writing to the Engineer.
- H. All Work shall be scheduled and completed within the normal progress of the project. Any additional work required by other trades that may be caused by the scheduling of this Contractor, shall be borne solely by the Contractor.

1.15 WARRANTY

- A. All Systems, equipment, Materials and devices shall carry a minimum of a two year warranty. As indicated elsewhere in these documents, individual sections shall require warranty periods in excess of this length of time.
- B. All warranties shall begin at the time of acceptance by the Owner of the entire project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All Base Bid submissions shall be derived from the provision of the Materials specified, or the alternatives listed.
- B. All materials shall be new and U.L. Labeled for the Application.
- C. For any Materials drawn or specified as being supplied by a single manufacturer, the Contractor shall provide said Materials as Drawn or Specified.
- D. All manufacturers of the systems and infrastructure indicated shall verify to the satisfaction of the Contractor, Owner and Engineer that the systems and infrastructure as indicated on the Documents will function properly and perform as specified under the conditions indicated on these Documents.

All parameters of the systems and infrastructure, including but not limited to, weight, dimensions, environmental conditioning, power, etc. shall be verified prior to shop drawing submittals.

- E. All Materials shall be provided so as to fully enable the Owner to be afforded the maximum warranties available. This includes, but is not limited to, furnishing the Materials through manufacturers approved supply and distribution methods, and 100% of the installation, termination and commissioning, i.e. testing and documentation, by certified installation contractors where applicable.

2.2 MATERIAL SUBSTITUTIONS

- A. No substitutions for the Materials specified shall be permitted without a formal written request for Material substitution.
- B. Material substitutions, unless specifically indicated in writing by the Owner, Architect or Construction Manager in the Division 1 Specifications, or other governing front end documents, shall occur no later than two weeks prior to bid submission. The response to the request for substitution shall be returned no later than seventy two hours prior to the bid due date.
- C. Material Substitution requests shall be assembled with information for both the specified item and the proposed item assembled in such a manner so as to make the comparison of the like parameters readily available and discernable. The Engineer reserves the right to reject any submission that does not comply with this requirement.
- D. The Owner/Engineer reserves the right to deny any/all product substitution requests for any reason.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions
 - 1. Visit the site of the work and become familiar with the conditions affecting the installation. Submission of a proposal shall presuppose knowledge of such conditions and no additional compensation shall be allowed where extra labor or materials are required because of ignorance of these conditions.
 - 2. Extra costs which might result from deviations from the Drawings, so as to avoid interferences, shall be considered a "Job Condition", and no additional compensation shall be considered applicable. In the event that such interferences occur in course of the Work, due to an error, omission, or oversight by the Contractor, no additional compensation shall be allowed. Interferences that may occur during the course of construction shall be brought to the immediate attention of the Architect and Engineer, and the Architect and Engineer's decision, confirmed in writing, shall be final.

3.2 INSTALLATION

- A. Coordination

1. The Contractor shall actively participate in the coordination efforts of all trades to assure both the proper execution of these Contract Documents, and the execution of the associated trades. Any deviation from the intent of these Documents caused by these coordination efforts shall be approved in writing by the Engineer prior to execution. The need for such changes shall be brought to the immediate attention of the Engineer for resolution.
2. The Contractor become familiar with the Contract Documents of the other trades, and shall adjust, as necessary, the layout of the associated technology devices, equipment and cabling so as to maintain the intent of the Documents and be compatible with the other trade's Documents.
3. The Contractor shall monitor the progress and Work of all trades that may have impact on the execution of the Documents. The Contractor shall bring attention to all Work by other trades that may have detrimental effect on the outcome of this Contractor to the immediate attention of the CM and the Engineer. Any rework required by lack of action by the Contractor on this behalf shall be borne by the Contractor, and shall be completed so as to be complaint with the original applicable Drawings and Specifications.
4. Devices and equipment not specifically dimensioned and located on the Documents shall be oriented so as to be both aesthetically consistent with the devices, equipment and other architectural elements in its' general proximity, and consistent with the standard practices and workmanship of this types of installation.
5. Do not install in, or attach to, the work of any other trade that is deficient or otherwise incomplete, unless by doing so, the completion of work by the other trades is not impeded or prevented.
6. Do not obstruct access to, or the installation of, other trades.
7. Prior to the commencement of Work, provide the Electrical and Mechanical Contractors with reproducible marked up prints indicating all locations where technology devices and equipment interact with any mechanical, plumbing and electrical equipment. Refer to the Mechanical, Electrical and Architectural specifications for additional requirements.
8. Review the layout of other trades for devices and/or equipment that are to be located within any Telecommunications or Low Voltage Equipment Spaces. Inform the Engineer immediately of any occurrence of this nature. The Owner reserves the right to require the Technology Contractor to rectify any occurrence of this nature that has occurred after execution of the Contract with the Contractor that was not explicitly indicated on the related Contract Documents, the cost of which shall be borne by the Contractor.

B. Wiring Methods

1. Install cables in raceways and cable trays except within consoles, cabinets, desks and counters. Conceal raceway and cables except in unfinished spaces, unless otherwise noted.

C. Firestopping

1. Comply with requirements in Division 07 Penetration Firestopping.

2. Comply with TIA-569-D, Annex A, “Firestopping”.
 3. Comply with BICSI TDMM, “Firestopping Systems” Article.
- D. Grounding
1. Install grounding according to BICSI TDMM, “Grounding, Bonding and Electrical Protection” Chapter.
 2. Comply with TIA-607-B and NECA/BICSI-607
- E. Labeling
1. 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
 2. All cabling, equipment and related hardware shall be labeled by means of either a machine generated, or pre-printed label designed specifically designed for the application for which it is being utilized. Or, in cases where a device is mounted or installed in a permanent fashion, i.e. permanently attached to structure, provide an engraved phenolic tag. For additional information, refer to the various Specification Sections.
- F. Record Drawings
1. The Contractor shall keep on the job site one complete set of drawings that shall be utilized as an ongoing record of the job. All markings shall be in pen unique colors from those used to create the print. These drawings shall be maintained on a daily basis, and shall indicate all deviations from the Contract Documents. These drawings shall be made available to the Engineer or Owner for review at the jobsite. Should these documents require to be viewed off-site, the Contractor shall make color reproductions prior to transportation from the jobsite, and forward the color reproductions. The Contractor shall remain responsible for the jobsite record mark ups.
 2. At the completion of the project, the mark ups shall be incorporated into the electronic files by the Contractor, and shall be submitted to the Engineer in both hard and electronic copies for approval, along with the original marked up set. The Contractor shall request and receive from the Engineer one copy of the original design files from which the Contractor shall perform the editing to reflect as-built conditions. These edited drawings shall be reviewed for general content and acceptability. Once approved, and returned to the Contractor, the Contractor shall make any necessary corrections, and submit one set, both electronic and hard, to the Engineer and one set, both electronic and hard, to the Owner for the Owner’s As-Built record.
 3. Should, for whatever reason, the scope of the Division 27 and/or 28 be, or become, subdivided into multiple bid packages, it shall be the responsibility of the structured cabling contractor to produce, and submit, the Record Drawings. Any other contractor required, due to the subdivision of this package, shall provide the structured cabling contractor with the necessary electronic files necessary to insert this information in the master files, and produce these Record Drawings.

4. All drawings, including but not limited to those submitted to the structured cabling contractor for inclusion in the submission, shall be in native format of those files received by the Contractor from the Engineer. Each system and related cabling shall be on individual layers in AutoCAD, or model categories in Revit. The Contractors shall maintain the title blocks and other graphic representations of the Owner, Architect, Engineer and other Design team members present on the Documents, less the Engineer's State Registration or other certification moniker. Any stamp, certification moniker or company logo of the Contractor, its agent or assigns shall be incorporated only to the extent that it does not exceed the size of corresponding design team member stamp, certification moniker or company logo. Should the Contractor not have the ability to provide the required drafting and/or modelling, either through insufficient skill-set or lack of necessary software, the Contractor may obtain a cost from the Engineer to provide such services.

G. Codes and Fees

1. The Contractor shall secure and pay for any and all permits and fees required by the execution of this project, including but not limited to, any and all periodic inspections that may be required. At the time of job completion, the Contractor shall turn over to the Owner, at no additional cost, all certificates of inspection, approval and occupancy. Such submission to the Owner shall be a condition of job close out and completion.
2. The Contractor shall provide all necessary notices of progress and completion to all required authorities so as to assure compliance with all codes and regulations.

H. System And Service Shutdown

1. The Contractor shall provide sufficient notice to the Owner and Engineer of any required system or service shutdown. Unless previously agreed to in writing by the Owner and Engineer, such notifications shall occur a minimum of two weeks in advance. The Owner reserves the right to require longer lead times in shutdowns. The Contractor shall review these lead times with the Owner and Engineer prior to commencement of work.
2. Systems and services routed through areas of construction and/or demolition shall be identified in advance and protected during construction. Should any trade be required to perform work that may jeopardize these systems or services the Owner shall be made aware of this jeopardy. The Contractor shall make this known to all trades in writing. A copy of this notification shall be forwarded to the Engineer at the time of distribution.
3. All efforts required for the coordination or performance of these systems or service shutdowns, including but not limited to any premium time compensation, shall not garner additional compensation from the Owner.

3.3 SYSTEM STARTUP

- A. All Work shall include system startup by appropriate personnel. Where applicable, only individuals trained and certified by the manufacturer may authorize and or carry out such system startup. Personnel carrying out such startup shall keep written records of the procedures executed and subsequent results. A copy of such records and results shall be given to the Owner for their records prior to the application for final payment.

3.4 REPAIR AND RESTORATION

- A. All cutting and patching in during normal construction, as well as any retrofit construction, necessary for installation of this work shall be the responsibility of this Division. Have cutting done by skilled mechanics as carefully as possible and with as little damage as possible. Do not cut any structural member without specific permission from the Architect.
- B. The Technology Contractor shall assume removing existing ceiling to install new work and replacing with existing or new ceilings as required for installation of all work under this Division. These areas include spaces not only in the new work, but areas in the existing building where the Contractor is required to install new work. Damaged tiles shall be replaced with new tiles. Any tiles removed from the customer stock shall either be replaced with an exact replacement, or the Owner shall be reimbursed for the Owner's full cost of the materials including any shipping costs incurred.

3.5 REINSTALLATION

- A. Any equipment removed and relocated, or removed and re-installed shall be cleaned, and retested as if new. Replace any expendable devices or accessories with new replacements, e.g. change out filters.

3.6 FIELD QUALITY CONTROL

- A. The Contractor's PM shall remain abreast of project progress and perform periodic walk through of work in progress and/or complete. During such walk thru's, the PM shall prepare internal punch lists indicating all Material or labor inadequacies or inaccuracies. All such items shall be corrected promptly. The Engineer reserves the right to review and/all such internal punch lists at the Engineer's discretion.
- B. The Engineer reserves the right to periodically perform walk thru's. During such times, the Engineer may create punch lists which shall be corrected promptly.
- C. All design work has been engineered so as to be completely compliant with all applicable codes and standards. Should actual field conditions require the non-adherence to any code or standard, the Contractor shall determine an acceptable alternative that will allow the installation to regain compliance, and contact the Engineer immediately to discuss this situation and advise of the alternatives determined by the Contractor.
- D. The Contractor shall inspect all cabling pathways prior to close out, and correct any anomalies that may have occurred, such as pathways inappropriately modified by other trades.

3.7 ADJUSTMENTS

- A. All devices and equipment with the capability of tuning, adjustment or calibration shall be set to the desired optimum configuration prior to the Owner training and project completion.

3.8 CLEANING

- A. All devices and equipment shall be wiped, swept and, where appropriate, washed to remove all traces of the construction environment. Such cleaning shall include, but not be limited to all points of user interface, racks, cabinets, patch panels, wall fields, equipment, devices, related hardware and

Technology Space floors. All cabling pathways shall be inspected by the Contractor, and any/all debris shall be removed prior to final close out.

- B. All areas subject to personnel traffic by the Contractor shall be completely cleaned.
- C. All areas where the Contractor stores tools and Materials shall be fully cleaned, such that any user will be unable to be aware that the area had been used for the storage of tools and Materials.

3.9 DEMONSTRATION

- A. The Owner shall have each system demonstrated to, at a minimum, the Engineer showing the complete operability of the system and/or infrastructure prior to Acceptance by the Owner.
- B. The Owner shall be trained on the systems and infrastructure. For additional training requirements, refer to the various Specifications Sections. All training shall be video taped in its' entirety on standard VHS tape, and turned over to the Owner at no additional cost.

3.10 PROTECTION

- A. All existing Materials, equipment, devices, cabling and related hardware remaining in place shall be protected from damage during the construction project. Any Materials, equipment, devices, cabling and related hardware damaged during the course of the project shall be replaced by new items that match exactly, or are greater product. All financial liability for this replacement, including but not limited to, the required labor by a properly certified individual, shall be borne by the Contractor.
- B. All Materials, equipment, devices and related hardware being removed and relocated, in addition to be protect as defined in the previous paragraph shall be stored while waiting to be re-installed, in such a fashion so as to protect the Materials, equipment, devices, and related hardware from damage. Any items requiring replacement shall be replaced by new items that match exactly, or are greater product.
- C. During the course of the project, the Contractor shall, on a regular basis, protect and inspect the work previously completed or in progress. The Contractor shall correct any work that has become unacceptable or below standard. Such corrective measures shall be the financial responsibility of the Contractor until the time of Owner acceptance.

3.11 SCHEDULE

- A. The Contractor shall be liable to follow the ongoing construction schedule as defined and managed by the Construction Manager.
- B. The Contractor shall remain abreast of any changes to the schedule and assess the ability to maintain the schedule with the changes indicated. The Contractor shall immediately make the Engineer aware of said changes.

END OF SECTION 270100

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SECTION 270524 – COMMUNICATIONS FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section includes the fire stopping requirements for the Division 27 and 28 portions of the project. Should conflicts arise between this portion of the requirements and those required by the Architectural Specifications, the Contractor shall utilize the more stringent requirements. Items covered in this Section include, but are not limited to,
 - 1. Firestopping of Through Penetrations in Fire Rated Assemblies.
 - 2. Smoke Seals.
 - 3. Construction enclosing compartmentalized areas.

1.2 RELATED SECTIONS

- A. Section 270100 – Communications Common Work Results
- B. Section 270200 – Communications Demolition
- C. Section 270526 – Grounding and Bonding for Communications Systems
- D. Section 270528 – Pathways for Communications Systems
- E. Section 270544 – Sleeves and Sleeve Seals for Communications Pathways and Cabling
- F. Section 271100 – Communications Equipment Rooms Fittings
- G. Section 271313 – Communications Copper Backbone Cabling
- H. Section 271323 – Communications Optical Fiber Backbone Cabling
- I. Section 271513 – Communications Copper Horizontal Cabling
- J. Section 272100 – Data Communications System
- K. Section 273100 – Telephony System
- L. Section 274116 – Audio Visual Systems
- M. Section 275113 – Public Address Systems
- N. Section 275123 – Intercom Systems
- O. Section 275313 – Wireless GPS Clock Systems
- P. Section 280513 – Conductors and Cables for Electronic Safety and Security

- Q. Section 281300 – Access Control
- R. Section 282300 – Video Surveillance
- S. Division 1 – General Requirements
- T. Division 2 – Earthwork
- U. Division 7 – Firestopping
- V. Division 9 – Finish Painting
- W. Division 11 – Equipment
- X. Division 14 – Conveying Systems
- Y. Division 25 – Mechanical
- Z. Division 26 – Electrical

1.3 REFERENCES

- A. ASTM E 84, “Surface Burning Characteristics of Building Materials”.
- B. ASTM E 119, “Fire Tests of Building Construction and Materials”.
- C. ASTM E 814, “Fire Tests of Through Penetration Firestops”.
- D. ANSI/UL263, “Fire Tests of Building Construction and Materials”.
- E. ANSI/UL723, “Surface Burning Characteristics of Building Materials”.
- F. ANSI/UL1479, “Fire Tests of Through Penetration Firestops”.
- G. Uniform Building Code published by ICBO.
- H. Standard Building Code published by SBCCI.
- I. National Building Code published by BOCA.
- J. International Building Code published by ICC.
- K. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
- L. National Fire Protection Association (NFPA) – NFPA 101: Life Safety Code.
- M. National Fire Protection Association (NFPA) – NFPA 70: National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, adds and changes will occur.

- B. Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
- C. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
- D. Openings for cable trays shall be sealed using re-enterable firestopping pillows.

1.5 SUBMITTALS

- A. All submittals shall conform completely with the requirements of the Contract Documents.
- B. Product Data
- C. For each type, provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.
- D. Shop Drawings
 - 1. Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings. Show typical installation details including:
 - a. Minimum and maximum allowable annular spacing
 - b. Base material composition
 - c. Firestop materials selected
 - d. Applied thickness required to achieve the hourly rating
- E. Certificates
 - 1. Submit product certificates signed by firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.
- F. Installation Instructions
 - 1. Submit manufacturer's printed installation instructions.

1.6 QUALITY ASSURANCE

- A. Products/Systems: Provide firestopping systems that comply with the following requirements:
 - 1. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
 - 2. Firestopping products bear the classification marking of qualified testing and inspection agency.

- B. Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multicomponent products.
2. Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

B. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 PROJECT CONDITIONS

- A. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- B. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- D. Do not use materials that contain flammable solvents.
- E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- G. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

1.9 WARRANTY

- A. Contractor shall provide written certification that all firestopping was installed in accordance with the manufacturer's written instructions for UL tested assemblies and that all firestop systems installed meet the firestopping requirements as herein specified.

1.10 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes or cut openings to accommodate through-penetration firestop systems.
- C. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

1.11 PROTECTION

- A. Where firestopping is installed at locations which shall remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.2 MATERIALS

- A. General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.
- B. Fire Rated Cable Pathways: Factory manufactured devices comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway
 - 2. Hilti Speed Sleeve
 - 3. 3M Fire Barrier Pass Through Device, Square
- C. Latex Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant
 - 2. Hilti Elastic Firestop Sealant
 - 3. 3M Fire Barrier Silicone Sealant
- D. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty

2. Hilti Firestop Putty
 3. 3M Fire Barrier Moldable Putty
- E. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows
 2. Hilti Firestop Cushions
 3. 3M Fire Barrier Pillows

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.
- B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to protect adjacent surfaces.
- D. Do not proceed until unsatisfactory conditions have been corrected.
- E. Verify that environmental conditions are safe and suitable for the installation of the firestop products.

3.2 INSTALLATION

- A. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.
- C. All firestopping shall be installed in accordance to the UL rated system designed for the application.
- D. Sleeves and core-drilled holes shall be sized at least 1-1/2" larger in diameter than penetrating items.
- E. Installation of firestops shall be performed by applicators/installers qualified and trained by the Manufacturer.
- F. Coordinate with plumbing, mechanical, electrical and other trades to assure that all conduits, raceways, cables, cable trays, and other equipment which penetrate fire rated construction have been permanently installed prior to installation of firestops. Schedule and sequence the work to assure that partitions and other construction which would conceal penetrations are not erected prior to the installation of firestop.

- G. Gun grade sealants and putties shall be tooled into place to insure proper adhesion to penetrations and surrounding surfaces.

3.3 FIELD QUALITY CONTROL

- A. Keep areas of work accessible until inspection by authorities having jurisdiction.
- B. Where deficiencies are found, repair firestopping products so they comply with requirements.
- C. Install work in full accordance with the rules, regulations, and safety requirements of Federal, State, County and City authorities having jurisdiction over premises. Do not construe this as relieving Contractor from compliance with any requirements of the Specifications which are in excess of Code requirements and not in conflict therewith.
- D. Correct unacceptable firestopping and provide additional inspection to verify compliance with this Specification at no additional cost.
- E. Finish surfaces of firestopping that is to remain exposed in the completed work to a uniform and level condition.

3.4 ADJUSTING AND CLEANING

- A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

END OF SECTION 270524

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. Grounding conductors.
- 2. Grounding connectors.
- 3. Grounding busbars.
- 4. Grounding rods.
- 5. Grounding labeling.

1.3 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. EMT: Electrical metallic tubing.
- C. TGB: Telecommunications grounding busbar.
- D. TMGB: Telecommunications main grounding busbar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For grounding and bonding system. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. System attachment points.
 - 2. Ground and roof rings.

3. BCT, TMGB, TGBs, and routing of their bonding conductors.
 - B. Qualification Data: For project manager, installation supervisor, and field inspector.
 - C. Qualification Data: For testing agency and testing agency's field supervisor.
 - D. Field quality-control reports.
- 1.6 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For grounding 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. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

- A. Comply with J-STD-607-A.

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 Grounding Wire: No. 6 AWG.
- C. Cable Tray Grounding Jumper:
 1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding 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 grounding screw or connector provided by cable tray manufacturer.

2. Not smaller than No. 10 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding 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. Tinned Conductors: ASTM B 33.
4. Bonding Cable: No. 6 AWG, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 6 AWG, stranded conductor, minimum UON.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch 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. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
- D. Busbar Connectors: Cast silicon bronze, solderless compression, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings, minimum 14". The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide a 4-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.
- B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings, 14" minimum. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.
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 Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical Busbar: 72" long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding 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 BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT 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 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 J-STD-607-A.

3.3 APPLICATION

- A. Conductors: Install stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
- C. 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.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- E. Grounding and 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 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - 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 TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG, UON.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 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. Pre-twist the conductor.
 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size

shall not be less than 2 kcmil/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the TGB.

3.7 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 grounding requirements.
- C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.8 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- 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 TMGB and a TGB 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 grounding 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 grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Grounding 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. Optical-fiber-cable pathways and fittings.
 - 3. Metallic surface pathways.
 - 4. Hooks.
 - 5. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Pathway hardware
 - 2. Wireways and fittings.
 - 3. Boxes, enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.
- C. Samples: For wireways, nonmetallic wireways, surface pathways and tele-power poles and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway 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 pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Qualification Data: For professional engineer.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - 3. Material: match conduit material.
 - 4. Type: Set screw.
 - 5. 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.
 - 6. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch with overlapping sleeves protecting threaded joints.

- F. 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 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum installation unless otherwise indicated.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.

2.3 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. Stainless steel.
- E. J shape.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 - 4. Device Box Dimensions: 4-11/16 inches by 4-11/16 by 2-1/8 inches
 - 5. Gangable boxes are prohibited.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Metal Floor Boxes (Unless Otherwise Specified in the Drawings):
 - 1. Material: Cast metal

2. Type: Fully adjustable.
 3. Shape: Rectangular, with dedicated provisions for structured cabling
 4. 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.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. 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.
 - d. Gymnasiums
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Damp or Wet Locations: GRC.
 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
 7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
 8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT>.
 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.
- B. Minimum Pathway Size: 1-1/4 inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- C. 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 set-screw, steel fittings. Comply with NEMA FB 2.10.
- D. Install surface pathways only where indicated on Drawings.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 105.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270528.29 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

- K. Support conduit within 12 inches of enclosures to which attached.
- L. Pathways 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 pathways to reinforcement at maximum 10-foot intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
 4. Do not embed thread-less fittings in concrete unless specifically approved by Architect for each specific location.
 5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. 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.
- O. 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.
- P. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- Q. 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.
- R. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- S. Install pull wires in empty pathways. 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. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- T. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet

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.
- U. 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.
- V. 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.
- W. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 4. Space hooks no more than 5 feet o.c.
 5. Provide a hook at each change in direction.
- 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 of 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-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 of concrete around conduit 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.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping" and 270524 "Firestopping for Communications Systems"

3.6 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 270528

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the requirements for cable tray and runway, including but not limited to:

1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Cable tray accessories.
4. Warning signs.

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.

B. These Specifications shall be construed in concert with the Owner's Standards. As such, relative to installation practices, should the published Specifications come in conflict with the Owner's published requirements, the more stringent requirement shall comply. With regards to materials, the Owner's requirements shall take precedence unless such requirements are not in compliance with current codes and/or industry standards. For those instances where no materials are specified within the Owner's document, the requirements of these Specifications shall remain in force. The requirements attached are recent revisions of the documents. However, the Contractor shall obtain and utilized the latest revisions available at the time of bidding and construction.

C. Related Requirements:

1. Section 270100 – Communications Common Work Results
2. Section 270524 – Communications Firestopping
3. Section 270526 – Grounding and Bonding for Communications Systems
4. Section 270528 – Pathways for Communications Systems
5. Section 270543 – Underground Pathways and Structures for Communications Systems
6. Section 271100 – Communications Equipment Rooms Fittings
7. Section 271323 – Communications Optical Fiber Backbone Cabling
8. Section 271513 – Communications Copper Horizontal Cabling

9. Section 281300 – Access Control
10. Section 282300 – Video Surveillance
11. Section 284810 – Emergency Responder Radio System Testing
12. Division 1 – General Requirements
13. Division 2 – Earthwork
14. Division 7 – Firestopping
15. Division 9 – Finish Painting
16. Division 11 – Equipment
17. Division 14 – Conveying Systems
18. Division 25 – Mechanical
19. Division 26 – Electrical

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.

2. Vertical and horizontal offsets and transitions.
 3. Clearances for access above and to side of cable trays.
 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
- B. Source Limitations: Obtain cable trays and components from single manufacturer.
- C. Sizes and Configurations: See the Drawings for specific requirements for types, materials, sizes, and configurations.
- D. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAY

- A. Utilized in any/all Telecommunications Room/Audio-Visual Server Room
- B. Description:
1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
 2. Width: As indicated on Drawings, minimum 18".
 3. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
 4. Rung Spacing: 9 inches o.c.
 5. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.

6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
7. No portion of the rungs shall protrude below the bottom plane of side rails.
8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
9. Splicing Assemblies: Bolted type using serrated flange locknuts.
10. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:
 - a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Powder-coat enamel paint.
 - 1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - 2) Hardware: Chromium-zinc plated, ASTM F 1136.
 - e. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

D. Manufacturer and Part: Hubbell HLS06**B

2.3 WIRE-MESH CABLE TRAY

A. Utilize for all tray on the Drawings, except that which occurs within the Telecommunications Room/Audio-Visual Server Room

B. Description:

1. Configuration: steel wire mesh, complying with NEMA VE 1.
2. Width: 18 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches unless otherwise noted on the Drawings.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
6. Splicing Assemblies: Bolted type using serrated flange locknuts.

7. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:
 - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

- D. Manufacturer and Part: Cablofil CF-XXX series tray. Equal by Hubbell and Chatsworth.

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

- A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.

- E. Fasten cable tray supports to building structure.
- F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- I. Support bus assembly to prevent twisting from eccentric loading.
- J. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- L. Support wire-basket cable trays with trapeze hangers.
- M. Support trapeze hangers for wire-basket trays with 3/8-inch diameter rods, unless otherwise noted.
- N. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install barriers to separate cables of different systems, such as power, communications, audio/visual and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- U. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- V. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with hook, and loop fastening strips.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after equipment has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and systems of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 7. Check for improperly sized or installed bonding jumpers.
 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
- B. Prepare test and inspection reports.
- 3.6 PROTECTION
- A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the requirements for the equipment materials and installation practices for the fit out of the Communications and Audio/Visual Equipment Rooms, and includes by is not limited to:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Power strips.
5. Grounding.

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.

B. Related Sections:

1. Section 270200 – Communications Demolition
2. Section 270524 – Communications Firestopping
3. Section 270526 – Grounding and Bonding for Communications Systems
4. Section 270528 – Pathways for Communications Systems
5. Section 271100 – Communications Equipment Rooms Fittings
6. Section 271323 – Communications Optical Fiber Backbone Cabling
7. Section 271513 – Communications Copper Horizontal Cabling
8. Section 275123 – Intercom Systems
9. Section 281300 – Access Control System
10. Section 282300 – Video Surveillance
11. Section 284810 – Emergency Responder Radio System Testing

- 12. Division 1 – General Requirements
- 13. Division 2 – Earthwork
- 14. Division 7 – Firestopping
- 15. Division 9 – Finish Painting
- 16. Division 11 – Equipment
- 17. Division 14 – Conveying Systems
- 18. Division 25 – Mechanical
- 19. Division 26 – Electrical

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. LAN: Local area network.
- C. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Layout Technician, Installation Supervisor, and Field Inspector.

1.6 QUALITY ASSURANCE

- A. The terms RCDD, Registered Technician, and Registered Installer shall be as defined and certified by BICSI.
- B. Installer Qualifications: Cabling Contractor/Installer must have personnel certified by BICSI on staff as full time employees. Use of Contract employees to fulfill these quality assurance roles if unacceptable.
 - 1. Project Manager: Full time employee for the Contractor/Installer, and currently Registered with BICSI at the time of bid submission and throughout the duration of the project. Project manager shall act as the sole point of contact and shall bear responsibility for the quality review and assessment of all Work of this Scope
 - 2. Layout Responsibility: Preparation of Shop Drawings shall be by a full time employee of the Contractor/Installer and under the direct supervision of the RCDD assigned to this project.
 - 3. Installation Supervision: Installation shall be under the direct supervision of full time employee of Cabling Contractor/Installer who shall be a Registered Technician, and shall be present at all times when Work of this Section is performed at Project site.
 - 4. Field Inspector: Full time employee of Cabling Contractor/Installer, currently registered by BICSI as an RCDD and assigned to this project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 BACKBOARDS

- A. Backboards: AC Plywood, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."
 - 1. AC Plywood shall be painted with (2) coats of fire retardant white paint on ALL sides prior to installation. Backboards shall be mounted 6" above the finished floor with the blemish free side, or "A" side" facing the user, unless otherwise noted on the Drawings. The receptacles shown on the boards shall be mounted at 18 inches above the finished floor, unless otherwise noted, and shall be installed in surface mounted, single gang outlet boxes with stamped, sheet metal cover plates.
 - 2. Failure to paint or mount the backboard as indicated herein shall be corrected by removing all equipment and devices mounted to the backboard, making all necessary corrections, retouching all paint on the backboard and mounting and/or painting the backboard as specified. Any blemishes shall be corrected so as to provide backboard in like new condition, at the discretion of the Engineer. The cost for any/all corrective actions shall be borne by the Contractor responsible for the hanging of the plywood. All equipment being removed and remounted shall be completed by the provider of said equipment so as to not void any warranties, and assure no damage to the devices and/or equipment. Such costs for

this removing and remounting shall also be borne by the Contractor responsible for hanging the plywood.

2.3 EQUIPMENT FRAMES

A. General Frame Requirements:

1. Distribution Frames: Freestanding and 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.
4. Manufacturers: Ortronics, Panduit, Great Lakes, unless otherwise noted

B. Floor-Mounted Racks: Modular-type, steel construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.

C. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Roof-mounted, 550-cfm fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.
11. Middle Atlantic ERK Series, 44U x 25" Deep

D. Modular Wall Cabinets:

1. Wall mounting.
2. Steel construction.
3. Treated to resist corrosion.
4. Lockable front and rear doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Roof-mounted, 250-cfm fan.
9. Power strip.
10. All cabinets keyed alike.

E. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.
5. Horizontal: 2U as manufactured by rack manufacturer
6. Vertical: 6" as manufactured by the rack manufacturer

2.4 POWER STRIPS

A. 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. Rack mounting.
3. Six 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.

6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
8. Cord connected with 15-footline cord.
9. Rocker-type on-off switch, illuminated when in on position.
10. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

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 270528 "Pathways for Communications Systems" for materials and installation requirements for pathways.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment 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.
- D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with 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 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 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 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.

3.5 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-B and Section 270526 Grounding for Communications Systems.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 260553 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

- C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration including optional identification requirements of this standard.
- D. Labels shall be preprinted or computer-printed type.

END OF SECTION 271100

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER 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.

B. Related Sections

1. Section 270524 – Communications Firestopping
2. Section 270526 – Grounding and Bonding for Communications Systems
3. Section 270528 – Pathways for Communications Systems
4. Section 271100 – Communications Equipment Rooms Fittings
5. Section 272100 – Data Communications System
6. Section 273100 – Telephony System
7. Section 274116 – Audio Visual Systems
8. Section 280513 – Conductors and Cables for Electronic Safety and Security
9. Section 281300 – Access Control
10. Section 282300 – Video Surveillance
11. Division 1 – General Requirements
12. Division 2 – Earthwork
13. Division 7 – Firestopping
14. Division 9 – Finish Painting
15. Division 11 – Equipment
16. Division 14 – Conveying Systems
17. Division 25 – Mechanical
18. Division 26 – Electrical

1.2 SUMMARY

A. Section Includes:

1. Multi-mode optical fiber cable.
2. Single mode, inside plant optical fiber cable.
3. Optical fiber cable connecting hardware, patch panels, and cross-connects.
4. Cabling identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. IDC: Insulation displacement connector.
- D. LAN: Local area network.
- E. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 3. Cabling administration drawings and printouts.
 4. Wiring diagrams to show typical wiring schematics including the following:
 - a. Telecommunications rooms plans and elevations.

- b. Telecommunications system access points.
 - 5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
 - C. Fiber optic cable testing plan.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For RCDD, installation supervisor, and field inspector.
 - B. Source quality-control reports.
 - C. Product Certificates: For each type of product.
 - D. Field quality-control reports.
- 1.7 CLOSEOUT SUBMITTALS
- A. Test Results
 - B. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable 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.
- 1.9 PROJECT CONDITIONS
- A. 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.
- 1.10 COORDINATION
- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Manufacturers: Superior Essex/Ortronics, Berktek/Leviton, Panduit

- B. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- D. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- E. Grounding: Comply with TIA-607-B.
- 2.2 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)
 - A. Description: Multimode, 50/125-micrometer, 12 and 24-fiber, armored, tight buffer, optical fiber cable.
 - B. Conductive cable shall be aluminum armored type.
 - C. Maximum Attenuation: 3.00 dB/km at 850 nm; 1.00 dB/km at 1300 nm.
 - D. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
 - E. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.
 - F. Jacket:
 - 1. Jacket Color: Aqua.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
 - G. Comply with ICEA S-83-596 for mechanical properties.
 - H. Comply with TIA-568-C.3 for performance specifications.
 - I. Comply with TIA-492AAAC for detailed specifications.
 - J. 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:
 - 1. Plenum Rated, Conductive: Type OFNP, complying with NFPA 262.

2.3 9/125 MICROMETER SINGLE-MODE, INSIDE PLANT OPTICAL FIBER CABLE (OS2)

- A. Description: Single mode, 9/125-micrometer, 12 fibers, single loose tube, armored optical fiber cable.
- B. Conductive cable shall be aluminum armored type.
- C. Maximum Attenuation: 0.7 dB/km at 1310 nm; 0.7 dB/km at 1550 nm.
- D. Jacket:
 - 1. Jacket Color: Yellow.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches
- E. Comply with TIA-492CAAB for detailed specifications.
- F. Comply with TIA-568-C.3 for performance specifications.
- G. Comply with ICEA S-83-596 for mechanical properties.
- H. 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:
 - 1. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.

2.4 OPTICAL FIBER CABLE HARDWARE

- A. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - 1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- B. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.
- C. Cable Connecting Hardware:
 - 1. Comply with Optical Fiber Connector Inter-mateability Standards (FOCIS) specifications of TIA-604-2-B for Type ST connectors, TIA-604-3-B for Type SC connectors, TIA-604-10-B for Type LC connectors, TIA/EIA-604-12 for Type MT-RJ connectors, and TIA-604-5-D for Type MPO connectors. Comply with TIA-568-C.3.
 - 2. Quick-connect, simplex and duplex, Type LC connectors unless otherwise indicated on drawings. Insertion loss not more than 0.25 dB.
 - 3. All terminations shall be fusion splice factory fabricated pigtails.

2.5 FIBER OPTIC CONNECTOR HOUSINGS

- A. The connector housing shall be rack mounted in a standard 19" rack utilizing one, two three or four units of standard height (1.75 inch EIA hole spacing).
- B. The connector housing shall utilize a modular connector plates for versatile connector configuration, with panels for SC, ST, and LC connectors.
- C. The connector housing shall be capable of flush or partially flush mounting with a front protector that shall be capable of readily mounting any required labeling.
- D. The connector housing shall be compliant with both ANSI/TIA/EIA-568A and ANSI/TIA/EIA-606.
- E. The connector housing shall utilize a slide out drawer assembly.
- F. The connector housing shall be capable of accepting a field installable lock mechanism.

2.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

2.7 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.
- C. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

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, in attics, 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 pathways specified in Section 270528 "Pathways for Communications 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 within enclosures. Connect 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 OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 301.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.1 and TIA-568-C.3.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced. 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.
 - 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 cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. 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.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 9. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
 - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
- E. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with Section 270524 "Communications Firestopping"
- C. Comply with TIA-569-D, Annex A, "Firestopping."
- D. 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 cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

- C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration including optional identification requirements of this standard.
- D. 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.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches 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. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- G. 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, for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.
- H. Backbone Risers
 - 1. Each Main or Intermediate Cross Connect shall contain a lexan covered copy of the riser diagram(s) associated with the backbone cabling serviced by the Cross Connect.
 - 2. The size of the plans shall be equal to the size of the Contract Drawings, unless Contract Drawings exceed 30" x 42", in which case half size prints are to be utilized.
 - 3. The plans shall be affixed by means of compression between the lexan cover and the backboard to which it is mounted. The Contractor shall make provisions to assure that the plans cannot accidentally fall from behind the lexan.

4. For cross connect locations that are smaller than TIA standard locations, half size plans shall be permitted.
 5. For locations that are serviced by wall mounted enclosures in shared spaces with other trades, the Contractor shall provide a laminated 8 ½" x 11" plan of only the riser diagram and basic title block information. The laminated copy shall be attached in a semi-permanent fashion to the enclosure.
 6. The Contractor shall utilize the final set of Record Drawings when providing these plans.
- I. All Fiber Optic Backbone cabling shall be marked, at both ends, with the exact source and destination information, i.e. Telecommunications Space ID, rack, patch panel and ports, or punch down block ID and ports. Each label shall be approximately 2" from the end of the sheath.
 - J. All Fiber Optic cabling shall have a warning tape, stating, at a minimum, "WARNING: Fiber Optic Cable" at each point of cable pathway that is accessible by the Owner, Owner's personnel, or other Contractor, and every 10' along continuously accessible pathways through which the cable is routed, such as above lay in ceilings.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Optical Fiber Cable 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) Horizontal and 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 those calculated according to equation in TIA-568-C.1.

- D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- E. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- F. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.7 SYSTEM AND SERVICE SHUTDOWN

- A. Any systems or service shutdowns that must occur after such time that services have begun to be distributed on the SCS, shall be coordinated with the Owner, and the affected trades, prior to shutdown.

3.8 REPAIR AND RESTORATION

- A. Any removal or rework of any structure or finish shall be restored to the original condition that the affected area was in prior to the removal or rework. All repairs and/or restoration shall be executed in a professional and workman like fashion by a tradesman skilled in such work. The Owner or Owner's authorized representative shall give written approval of all repairs and/or restoration upon its completion. Any repairs or restoration required as a function of work completed but not originally in project scope (i.e. accidental damage) shall be completed in same fashion outlined above at no additional cost to the Owner.

3.9 REINSTALLATION

- A. All device and equipment that is either removed and returned to its original location or removed and relocated shall be tested as if new. Should any device or equipment prove to be unable to pass such test, the SCC shall contact the Engineer for a resolution. Such resolution shall be given in writing before proceeding with the execution of the resolution.

END OF SECTION 271323

SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Cable management system.
4. Grounding provisions for twisted pair cable.

1.2 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 2. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 3. Cabling administration Drawings and printouts.
 4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment.
- D. Twisted pair cable testing plan.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.

- C. Source quality-control reports.
- D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. As-Built Documentation
- B. Test Results
- C. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.6 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: Superior Essex/Ortronics, Berk/Tek Leviton, Panduit/Panduit

2.2 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. Grounding: Comply with TIA-607-B.

2.3 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.4 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Cable Rating: Plenum.
- E. Jacket: Blue thermoplastic.

2.5 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer. Obtain twisted pair cable hardware from same manufacturer as twisted pair cable or from documented partner manufacturer, from single source.
- D. Connecting Blocks:
 - 1. 110-style IDC for Category 6.
 - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Patch Panel: Pre-loaded panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated.
- G. Patch Cords: Factory-made, from the manufacturer of the connectivity solution being provided, four-pair cables, one 1m and one 3m length per faceplate jack; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.

- H. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Standard: Comply with TIA-568-C.2.
 - 3. Marked to indicate transmission performance.
- I. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standard: Comply with TIA-568-C.2.
 - 4. Marked to indicate transmission performance.
- J. Faceplate:
 - 1. Two or Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
 - 2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 3. Metal Faceplate: Stainless steel, where metallic faceplates are either indicated on the Drawings or areas where corresponding electrical faceplates are metallic, complying with requirements in Section 262726 "Wiring Devices."
 - 4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
- K. Legend:
 - 1. Machine printed, in the field, using adhesive-tape label.
 - 2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 CABLE MANAGEMENT SYSTEM

- A. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.
- B. Information shall be presented in data grid view and technical drawings.
 - 1. AutoCAD drawing software matching the software used to create the Contract Documents shall be used as drawing and schematic plans software.

2.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

PART 3 - EXECUTION

3.1 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.

- B. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where open architecture cable routing 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 270528 "Pathways for Communications Systems."
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.
- D. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.1.
 - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. Cables may not be spliced. 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.
 - 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. 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, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 - 9. 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.
 - 10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
 - 12. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
 - 1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
- G. Copper Cabling Colors
 - 1. Verify exact colors with Owner prior to procurement.
 - 2. Provide colors for both horizontal and patch cord cabling.

- a. Data: Blue
- b. Wireless Access Points: Yellow
- c. Cameras: Purple

3.2 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.3 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with Specifications Section 270526 "Grounding and Bonding for Communications"; TIA-607-B and NECA/BICSI-607.
- C. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.4 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."
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.
- C. Equipment grounding conductors.
- D. Cable and Wire Identification:
 - 1. Label each cable within 4 inches 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 the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

- E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect twisted pair cabling jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair 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.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 27 15 13

SECTION 27 41 16 - CLASSROOM AV SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Work in this section includes, but is not limited to, furnishing and installing a fully integrated Audio-Visual presentation system in each Classroom, Reading Room, Media Center, Conference Rooms and Field House, and all other areas as indicated on the Drawings.

1.2 DESCRIPTION

- A. Each Classroom shall have an integrated audio and video system, as well as the required cabling, that shall include interactive monitor, and a voice amplification system, along with the associated cabling and audio/video connectivity.
- B. Each conference Room shall be provided with the interactive monitor specified within this Section, along with the required cabling, as a function of this Section.
- C. The voice amplification system shall include wireless RF microphones.
- D. The voice amplification system shall include input/output to/from program sources as indicated in the riser diagrams, providing any required sound reinforcement for these devices.
- E. The monitor shall provide both the selectivity of the video source switching, as well as providing audio switching to facilitate audio following video.

1.3 RELATED SECTIONS

- A. Section 27 05 00 – Communications Common Work Results
- B. Section 27 05 26 – Technology Grounding System
- C. Section 27 05 28 – Pathways for Communications Systems
- D. Section 27 15 01 - Structured Cabling System

1.4 PRODUCTS INCLUDE

- A. Products include, but are not limited to,
 - 1. Interactive Display Monitors
 - 2. Display Monitors
 - 3. Active Video Splitter
 - 4. Ethernet to RS-232 Converter
 - 5. Classroom Sound Reinforcement System, including:
 - a. Speakers
 - b. RF Wireless Mic(s)
 - c. Receiver/Mixer/Amplifier
 - d. RF Sensors
 - 6. USB to RJ-45 Adapter
 - 7. Cabling

- B. Refer to the Drawings for additional information and requirements.

1.5 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall currently maintain a locally run business for a minimum of five years and shall be an authorized distributor and service center for the supplied equipment having full warranty privileges.
- B. The Contractor shall maintain at his facility the necessary spare parts in the proper proportions as recommended by the equipment manufacturer to maintain and service the equipment being supplied. This facilities and inventory shall be made available for inspection by the Engineer.
- C. The Contractor shall maintain current applicable certifications for the systems being provided, including but not limited to Certified Technology Specialist (CTS) as provided by InfoComm, as well as certification by the specific manufacturer's where available, for the installation and servicing of all manufacturer's equipment being supplied and/or installed.
- D. The Contractor shall have a minimum of five installations of like magnitude and complexity within the last two years.

1.6 RECORD DRAWINGS

- A. As-built documentation for all variations of the systems provided under the scope of the Specification shall be provided to the Engineer for review and approval, upon approval of the Engineer, incorporate the drawings into the O&M manual provided to the Owner.
- B. As-built documentation as defined elsewhere in these Specifications shall contain, at a minimum:
1. Locations of all the systems provided, including, but not limited to any indications of variations,
 2. Riser(s) with all details of the individual installations, including, but not limited to,
 - a. Device or component manufacturer and model numbers,
 - b. Specific I/O points on the devices or equipment.
 - c. Type of cable(s), and any cable ID installed.
 - d. Nature of signal being transmitted, such as HDMI, RF or IR Control.
 - e. Any other pertinent detail of the interconnection to assist in the ongoing maintenance and upkeep of the system.
 - f. Note: Where the systems provided repeat in layout, a single riser may be provided. However, any deviation of the installation, such as varying quantity of speakers, shall require a separate and unique riser for each deviation. Each riser required shall be provided with a unique title so as to make it easily identifiable when being referenced. Should such deviations exist, the plans indicating the location of each of the systems shall clearly indicate which riser is applicable to each individual occurrence of the system.
 3. A complete list of all equipment with Manufacturer, Model Number, Serial Number, and location of the equipment shall be compiled and turned over to the Owner representative prior to final acceptance of the project.
 4. Listing of all user serviceable parts, including, but not limited to, Manufacturer and Model number of part(s).
 5. As built documentation shall be processed in compliance with Specifications Section 27 05 00.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

- A. As indicated elsewhere in these documents, the products specified on these Construction Documents shall be furnished as indicated. Substitution of materials or products considered to be functionally equivalent, where not previously approved in writing by the Engineer, shall be unacceptable. Any deviation from the use of materials or products shall be handled in accordance with terms and conditions established elsewhere in the documents.

2.2 PRODUCTS

- A. All products shall be new, UL listed and comply with all applicable Federal, State and Local regulations.
- B. Interactive Display Monitors
1. The Interactive Display monitor shall have the following characteristics
 - a. Type "CM". Refer to Drawings for quantities
 - 1) Screen Size: 75" minimum
 - 2) Resolution: 4K UHD
 - 3) Touchscreen: Yes
 - 4) HDMI Inputs: (3)
 - 5) External Control: RS232, RJ45, Wi-Fi
 - 6) Sensor: IR
 - 7) Built-in Speakers: Yes
 - 8) CPU: Yes, internal Processor
 - 9) Passive Pen: Yes
 - 10) Audio Out: Yes
 - 11) Model: Match existing, LiteTouch 75
 - 12) In addition, provide (1) Google ChromeBox for each monitor
 - a) Contractor shall match existing ChromeBox's as directed by the District.
 - b. Type "SG". Refer to Drawings for quantities
 - 1) Same characteristics as "CM" above
 - 2) Provide sound bar with mounting bracket under display monitor
 - 3) Model: Match existing LiteTouch 75
 - 4) In addition, provide (1) Google ChromeBox for each monitor
 - a) Contractor shall match existing ChromeBox's as directed by the District.
- C. Monitor Quantities
1. All "CM" and "SG" monitors and associated mounting brackets, and ChromeBox's, shall partially be furnished by the Owner and partially furnished and installed by this Contractor.
 2. This Contractor shall remove and relocate all existing monitors, as directed by the Owner, and install complete with existing mounting brackets and hardware.
 - a. Verify exact quantity of existing monitors with District prior to procuring new monitors.
 - b. Contractor shall utilize District's integrator to remove and install existing monitors into new school to keep existing warranty.
 - 1) Contact: Lite the Nite Technologies
 - a) LTNTechnologies.com

3. This Contractor shall provide all remaining monitors and mounting brackets, and ChromeBox's, based on the quantity of monitors needed to complete 100% of the installations.
 - a. Contractor shall match existing monitors, mounting brackets and ChromeBox's as directed above and by the Owner.
- D. Active Video Splitter (Splitter)
 1. The Splitter shall be actively buffered.
 2. The Splitter shall have the following features:
 - a. Input: one (1) HDMI input
 - b. Output: two (2) HDMI output.
 - c. Output impedance: 75 Ohm.
 - d. Video input impedance: 75k Ohm.
 - e. Minimum bandwidth: 350MHz @ -3dB.
 3. The Splitter shall be capable of passing VGA to 4K computer and video resolutions without significant measurable signal degradation.
 4. The Splitter shall include the required power supply.
 5. The Splitter shall be supplied with two factory fabricated and terminated jumpers one 3' jumper for the connection from the Splitter to the PC, and one jumper to provide the required connection from the Splitter to the connectivity at the work area outlet.
 6. Acceptable amplifier manufacturer and model
 - a. Extron DA2 HD 4K
 - b. Equal by Altinex, Kramer, or RGB Spectrum
- E. Ethernet to RS-232 Converter (Converter)
 1. The Ethernet interface shall provide the following features:
 - a. Connector: 1 RJ-45 female integral to the housing
 - b. Data Rate: 10/100Base-T, half/full duplex with autodetect
 - c. Protocols: TCP/IP, DHCP, HTTP, Telnet, SMTP, ICMP, UDP/IP, ARP
 2. Serial Control interface shall provide the following features:
 - a. Connector: DB-9 male, RS-232c
 - b. BAUD Rate: 300 to 115200 baud
 - c. Protocol: Adjustable
 - d. Pin Configuration: 2 = RX, 3 = TX, 5 = GND, 7 = RTS, 8 = CTS
 3. The Converter shall be powered by means of an included class 2 power supply or by means of 802.3af Power over Ethernet (PoE).
 4. The Converter enclosure shall be metal.
 5. The Converter shall be compliant with CE and FCC Class A, as well as any other applicable safety standard.
 6. The Converter shall be supplied with one RJ-45 factory fabricated jumper to connect the converter to the network, and one factory fabricated serial cable to connect the converter to the device being serviced.
 7. The Converter shall include software to create a useful Windows based graphic user interface for control and ability to view all parameters exposed by the device being serviced, such as hours of life for a projector lamp, or status of device operation, i.e. device on.
 8. Acceptable Manufacturer and Model
 - a. Extron IPL T S1
 - b. Kramer FC-1ETH
 - c. Crestron QM-RMC

F. Classroom Sound Reinforcement System (SRS)

1. The SRS shall consist of a packaged sound reinforcement system including, but not limited to, wireless RF microphones and associated charger(s), receiver/mixer/amplifier, speakers, and wireless microphone receivers.
2. In the case of adjacent classrooms with divisible walls, Contractor shall combine the (2) SRS's to function as one, where one SRS acts as the primary SRS. Contractor shall provide all associated cabling and components to accomplish this scenario.
3. The SRS shall include a minimum of:
 - a. One (1) wireless RF transmitter,
 - b. One (1) RF receiver/amplifier,
 - c. External remote RF sensors providing 100% RF coverage regardless of user position within the room,
 - d. One (1) collar microphone,
 - e. One (1) RF emitter for the transmitter,
 - f. One (1) hand-held RF student microphone for 25% of the classrooms,
 - g. Four (4) acoustical ceiling speakers, eight (8) where required by the application or where otherwise shown on the plan,
 - h. Cabling to connect speakers and external sensors to receiver/amplifier,
 - i. Four (4) nickel metal hydride batteries,
 - j. One (1) battery charger compatible with the rechargeable batteries of the wireless transmitters,
 - k. One (1) power supply for the receiver/amplifier.
 - l. Mounting bracket(s) as required
4. The Receiver/Amplifier shall include the following performance criteria:
 - a. Audio Power: 50 Watts peak, 50 Watts RMS
 - b. Frequency Response: 50Hz to 15kHz
 - c. Power Requirements: 24VDC, 2.5 amps with power supply
 - d. Signal-to-Noise: >80dB
 - e. Image rejection: >40dB
 - f. Reception sensitivity: >25dBuV
 - g. Reception selectivity: ± 40 kHz
 - h. Feedback rejection: dedicated circuitry to actively control feedback
5. The Controls shall include, but not be limited to:
 - a. One (1) master volume control
 - b. Individual inputs and volume controls for each channel that shall consist of a minimum of:
 - c. Two (2) teacher microphones
 - 1) TV/DVD
 - 2) Computer
 - 3) Auxiliary
 - d. A minimum 3-band equalizer
 - e. One (1) power switch
 - f. Voice Mute on/off selection
 - g. PA Mute which, when activated by means of receiving a public address announcement
 - h. Provide remote level control of microphone via RF
 - i. Provide automatic adjustable ducking to decrease the level of the multimedia presentation when the teacher speaks.
6. Connections, shall include, but not be limited to:

- a. A minimum of four individual inputs corresponding to the channels of control listed above utilizing RCA type, Hi Z, Mixed inputs
 - b. A dedicated line output
 - c. Independent speaker connections for each speaker provided in any given space.
 - d. Screw Terminal Connections for a minimum of:
 - 1) PA Mute
 - 2) Control Signal, controlled by a dedicated, single duty, remote pushbutton
7. 4-Channel Body Pack Transmitter
- a. The transmitter shall have the following performance criteria:
 - 1) Sub-carrier frequencies:sufficient quantity of frequencies to avoid interference from other classroom microphones
 - 2) Audio distortion: <1.0% ($\pm 40\text{kHz}$ deviation @ 1kHz)
 - b. The transmitter shall have the following features:
 - 1) Integrated microphone
 - 2) Internal charger circuit
 - 3) Built-in RF emitters
 - 4) Buttons:
 - a) power on/off
 - b) mute
 - c) Function F1 – triggers the logic output of the receiver/amplifier
 - 5) External Inputs
 - 6) Remote volume control for the system from the teacher’s transmitter
 - c. The power for the transmitter shall be by means of a rechargeable Nickel Metal Hydride or Lithium Ion battery in a standard “AA” form factor.
 - d. The transmitter shall utilize a pendant or lavalier RF microphone.
8. 4-Channel Hand Held Transmitter
- a. The transmitter shall have the following performance criteria:
 - 1) Sub-carrier frequencies:sufficient quantity of frequencies to avoid interference from other classroom microphones
 - 2) Audio distortion: <1.0% ($\pm 40\text{kHz}$ deviation @ 1kHz)
 - b. The transmitter shall have the following features:
 - 1) Integrated microphone
 - 2) Internal charger circuit
 - 3) Built-in RF emitters
 - 4) Buttons:
 - a) power on/off
 - b) push to talk
 - c) Function F1 – triggers the logic output of the receiver/amplifier
 - c. External Inputs – 3.5mm stereo mixed to mono within the microphone
 - d. Remote volume control for the system from the teacher’s transmitter
 - e. The power for the transmitter shall be by means of a rechargeable Nickel Metal Hydride or Lithium Ion battery in a standard “AA” form factor.
 - f. The transmitter shall utilize a handheld RF microphone.
9. External Dome Sensor (quantity as required for 100% RF coverage, regardless of teacher position in room)
- a. Power: Powered by receiver
 - b. Cable: Factory pre-terminated coax cable, plenum as required by code, of sufficient length to route the sensors to any position in the room as may be required without splicing, or providing substantial excess,
 - c. Mounting: Metal bracket

10. Speakers
 - a. Type: Ceiling mount with mounting brackets and plenum rated speaker backbox
 - b. Power handling: 50 Watts continuous
 - c. Impedance: 8 Ohms
 - d. Frequency Response: 100 Hz to 14 kHz +/- 3dB
 - e. Connection: Quick connect/disconnect speaker terminals
 11. System Wiring
 - a. Loudspeaker wiring shall be Class 2 or better. The wiring shall be classified for the environment in which it is installed. E.g. it shall be plenum-rated if it is installed in a ceiling plenum.
 12. Acceptable Manufacturer and Model:
 - a. Extron Pendant and Handheld VoiceLift Pro Microphone System
 - b. Equal by Lightspeed 955, Audio Enhancements, Bose, Phonic Ear or Listen Technologies
- G. USB to RJ-45 Adapter
1. The adapter shall be a bus powered.
 2. The adapter shall be packaged with both the receiver and transmitter pair.
 3. The adapter shall pass all required serial signaling to provision all operational aspects of the interactive whiteboard with the associated PC.
 4. The adapter shall be Tripp-Lie model U007-40M
 - a. Equal by APC or Sabrent
- H. Cabling
1. Provide all cabling and patch cords per Riser Diagram Drawings.
 2. HDMI cabling with cable equalizer
 - a. Plenum rated
 - b. Gold plated contacts
 - c. Resolution range
 - 1) 4K/60 verified for 25 feet
 - 2) 4K/60 verified for 35 feet with a cable equalizer
 - 3) 4K/30 verified up to 75 feet with a cable equalizer
 - 4) 1080p/60 verified up to 125 feet with a cable equalizer
 - d. Acceptable Manufacturer and Model
 - 1) Extron HDMI Pro series cabling with HD 4K 101 Plus cable equalizer
 - a) Equal by Liberty and Crestron with associated transmitters, receivers and additional cabling needed to extend HDMI cabling over 25 feet.
- I. Device and equipment receptacle stations and associated hardware.
1. All patch cords, cabling and related hardware, including mounting brackets, etc., implied and/or not explicitly indicated, but are required to complete the installation of the indicated systems shall be construed as being included in the requirements of the package, and shall be include in the base bid pricing. All aforementioned patch cords, cabling and related hardware shall be of high quality, compatible with the devices and equipment being provided and shall be manufactured by the same company as the other materials being provided whenever possible.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. This Contractor shall provide all necessary coordination with the Electrical Contractor to assure proper location of all related rough-ins prior to installation of rough-ins, and pathway requirements for all cabling associated with this system. Should coordination not occur, it will be the responsibility of This Contractor to provide all corrective measures. Such required corrective measures shall be provided only as approved by the Engineer, Architect AND Owner.
- B. This Contractor shall lead all discipline coordination for exact mounting height and location of power and data/AV rough-ins and faceplate for all projector and monitor locations. Provide exact wall and ceiling mounting templates for all trades to review and adhere to.
- C. Route all cabling in a neat and workman-like fashion.
- D. Terminate all field terminating cabling as recommended by the manufacture, and compliant with any applicable industry standards. All bare wire capture terminals shall be installed per manufacturer's recommendations. Where not specifically prohibited by the manufacturer, tin all bare wire compression connections.
- E. All connectors utilizing compression as the method for mechanical attachment to the cable shall utilize connectors that provide a single uniform compression around the entire diameter of the cable.
- F. Provide any/all recommended hardware to properly attach a ceiling or otherwise overhead devices and equipment, including, but not limited to, tile bridges or other ceiling anchor hardware.
- G. Provide labeling of any cable run whether factory provided or field installed cabling. Refer to the labeling requirements herein for further information and requirements.
- H. Configure the video monitor and projector switching such that audio follows video for the analog sources.
- I. Support and dress all cables. The Contractor shall provide all necessary fixed and flexible wire management to achieve a high-quality installation both visually and operationally, and that would be considered to be within the standard practices of good workmanship. Provide J-Hook supports at regular, though slightly varying, intervals of no greater than 5' for all cabling that must be routed greater than 5'. Provide a removable non-metallic sheath over all exposed cable bundles utilizing an easily flexible braided sleeving solution such as Techflex from the point where the cabling leaves the protection of the pathway to the device(s) being serviced, such as where the cabling leaves the wall or faceplate to the monitor or projector, or where the cabling leaves the wall to the receiver/amplifier and program sources.
- J. Within all equipment enclosures, and at the back of all equipment to the point where the cabling enters the equipment location, the Contractor shall utilize Velcro straps or Milli-Tie wraps for bundling of signal wires.
- K. Test all cabling for shorts, opens or other undesirable conditions. Replace any cabling found to be damaged or compromised in its ability to perform to that of a new and undamaged or uncompromised cable.
- L. Test all I/O and adjustability of the system, including providing any required test source or load that may be required to test any currently unused input or output.

- M. Verify complete operation of all components and the system as a whole. Correct all issues prior to final punch walk through.

3.2 LABELING

- A. The Contractor shall neatly label all cabling so as to assure easy maintenance and troubleshooting.
- B. Label all cabling at both ends at easily readable location that are no greater than 6" from the ends of the cable.
- C. Labeling shall be either laser-jet printed tags designed to adhere in a self-laminating fashion, or in field machine generated labels utilizing a commercial grade labeling machine designed for labeling cabling in such applications, and label stock designed for this specific application.
- D. Labeling shall be created so as to state the function and/or meaningful ID of the cable in recursive rows down the entire length of the label so the label is readable around the entire diameter of the cable.
- E. Label font shall be a clearly readable font, such as Arial, bold and no smaller than 1/8" high.

3.3 CALIBRATION AND COMMISSIONING

- A. The contractor shall verify signal level and signal integrity during installation and operation of the system. Should it be required to provide sufficient signal level and signal to noise ratio, as well as other industry accepted signal metrics, the Contractor shall provide distribution or buffer amplifiers to assure these sufficient signal levels as specified previously in this document. These line drivers would be in addition to any explicitly called out in these Documents.
- B. The Contractor shall calibrate all signals so that distribution of the signals shall be of a consistent and acceptable level minimizing and cascading signal to noise ratios while maintaining usable signal level.
- C. All installation and calibration of equipment shall be by qualified and certified personnel. All calibrations shall be checked by appropriate calibration equipment. Calibrations made by authoritative and/or experienced eyes and/or ears are not acceptable.
- D. All calibrations and adjustments shall be documented in machine generated print in a neat and organized fashion for transmission to the Owner. All documentation shall clearly identify the location of the equipment being documented, including, but not limited to manufacturer, model number and serial number. The Engineer reserves the right to review, reject or require modification or further documentation prior to completion of the project.
- E. The Engineer shall be given a minimum of 72 hours' notice prior to all final calibrations and commissioning and reserves the right to observe any and all final calibrations and commissioning. Should such courtesies not be extended to the Engineer prior to the final calibrations and commissioning, the Engineer reserves the right for the procedures to be completely repeated prior to considering job completion.

3.4 WORK COMPLETION

- A. The Contractor shall provide a complete and functioning system, based on the design intent set forth in these Construction Documents. Any and all equipment, either implied or intentionally omitted from these documents, but generally accepted as being required for the completion of the installation, as represented in these Construction Documents, shall be provided by the Contractor at no additional cost to the Owner.
- B. Each system component shall be individually tested, as well as tested in the complete system configuration, to assure 100% operability of each device, and compatibility of all components. All products and system configurations will be fully tested and operational prior to final payment.
- C. Contractor shall verify and produce documentation that every Sound Reinforcement system does not experience interference from every other Sound Reinforcement system.
- D. The Contractor shall provide a copy of all testing documentation to the Owner at the time of system commissioning and training.
- E. System Commissioning, including testing and certifications, shall be completed by a factory authorized representative prior to final payment. Said representative shall be fully certified by the manufacturer, and not simply an employee of the Contractor relying upon the Contractor's company certifications. All system operation or installation deficiencies shall be documented and submitted to the Owner at time of commissioning and shall be resolved prior to final training and final payment. Final payment shall be held until such time that final commissioning and training is completed to the satisfaction of the Owner and Engineer.
- F. The Contractor shall give a two week notice to the Engineer and Owner prior to system commissioning. The Engineer and Owner reserve the right to be present during the commissioning process to approve system configurations prior to the final punch list.
- G. Complete As-Built documentations shall be a pre-requisite for consideration of job completeness.

3.5 TRAINING

- A. The Contractor shall perform formal training with permanent staff personnel under the employ of the Owner.
- B. The Contractor shall utilize a formal sign in sheet that shall be included with the as-built documentation.
- C. Provide forty (40) hours training for School/District personnel on the operation, programming, and maintenance of the classroom sound reinforcement system and twenty (20) hours training for the School/District personnel on the operation, programming and maintenance of the interactive audio-video equipment.
- D. Provide two (2) digital video copies of all training.

3.6 WARRANTY

- A. Warranty of the system, including parts and on-site labor, shall be provided by the Contractor for all materials and workmanship for a period of three (3) years, or for the duration of the manufacturer's documented warranty whichever is greater. Should for some unforeseeable reason, the installer not be able to complete the term of the warranty, the manufacturer shall bear the complete responsibility

of the warranty for both parts and labor and shall appoint a certified service organization to complete the term of the warranty. The manufacturer shall inform the Owner of this appointment in writing. The Contractor shall present assurance of this stipulation from the Manufacturer to the Owner, in writing prior to commencement of work. Should the Contractor not provide this written assurance, the Owner shall retain the right, as outlined elsewhere in these Documents, to obtain satisfaction, including but not limited to, financial restitution to the Owner.

- B. The warranty period shall begin after substantial completion of all work, including Technology Bid Package systems, at which time, the installer shall provide service within a 24-hour period after notice by the Owner, for the duration of the warranty.

END OF SECTION 27 41 16

SECTION 27 41 17.1 - GYMNASIUM AUDIO VISUAL SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Work in this Section includes, but is not limited to, furnishing, and installing fully integrated audio-visual systems in the in the Gymnasium.
- B. This Section and the associated Drawings and Diagrams convey the intent of the design. The system(s) shall be provided in its entirety to provide a complete and working system(s) as expressed by this intent. Items drawn but not specified or specified but not drawn shall be provided as if included in both. Furthermore, it is incumbent on the Contractor to provide any device(s) required to make the system(s) fully functional to the intent of the design, whether indicated or not.
- C. Products Supplied but not installed by the Contractor
 - 1. The Contractor shall coordinate the delivery of items that must be installed by other trades to assure timely delivery.
 - 2. The Contractor shall verify lead times of all items required under this heading. Should the delivery of such items be delayed due to the Contractor's efforts, or lack thereof, the Contractor shall bear the burden of compensation to all related trades and for any expedited handling, so as to regain any loss incurred by the project schedule.
- D. Products Installed but not Supplied by the Contractor
 - 1. It shall be incumbent upon the Contractor to verify the exact requirements of any system, device, equipment, or Materials supplied to them for installation by others. Any deviations between the Contract Documents and these requirements shall be brought to the immediate attention of the Engineer, and to the other trades as necessary.
- E. Devices, equipment, or other infrastructure installed by other contractors in support of this Contractors efforts
 - 1. It shall be the responsibility of this Contractor to coordinate with the other contractors on the project who shall be providing items such as rough-in box and conduit to facilitate this Contractor's systems and device to verify the appropriateness and location of these items.
 - 2. This Contractor shall provide any necessary guidance as to the correctness of the information being used by these other contractors. Any item(s) either being provided out of Specification, in the wrong location, or inappropriate for the application shall be:
 - a. intervened upon immediately,
 - b. communicated to the CM/GC for resolution in writing,
 - c. communicated to the Engineer for resolution.
 - 3. Should the Contractor fail to coordinate, intervene and communicate the issue(s) to the aforementioned parties, it shall be the responsibility of this Contractor to correct such issues at the sole burden of this Contractor.

Note: It is understood and acknowledged that this Contractor cannot and shall not be held accountable for items of this nature, prior to this Contractor's authorized involvement in this project.

- F. Products furnished and/or installed by others requiring integration to the system
1. Products furnished and/or installed by others requiring integration to the system, e.g. Owner provided displays or projectors shall be fully integrated into the system.
 2. Coordinate with the provider of products.
 - a. Provide all needed interconnecting cabling and connectivity.
 - b. Provide all needed programming.
 - c. Locate all associated devices and materials to facilitate effective integration.
 - d. Coordinate with the Electrical Contractor to assure effective placement of any supporting infrastructure provided by EC.
 - e. Coordinate with the General Trades to assure effective placement of backing or other materials required.

1.2 DESCRIPTION

- A. The systems shall provide room divisibility between the two halves of each gym.
- B. The systems shall provide two distinct areas of sound distribution being bleachers and floor.
- C. The systems shall provide wireless microphone capability for both scorekeeping/tabletop/semi fixed location functionality and officiating/instructing or other active motion use.
- D. The systems shall include connectivity for the Owner provided projector, with wireless connectivity for source input to the projector, and audio output to the audio system.
- E. The systems shall include a wall mounted receptacle station for a wired connection from the audio output of the projector into the audio system.
- F. The systems shall include a program playback source at the equipment cabinet.
- G. The systems shall provide Bluetooth/Aux input connectivity.
- H. The systems shall provide control of audio devices by means of a control station providing source selection, individual and master volume control, as well as system/device power on and off utilizing a simple tactile user interface.
- I. The systems shall provide ADA required hearing assistance.
- J. The systems shall provide a key-switch override for use by first responders to facilitate emergency response directions to the occupants of the space.
- K. The systems shall provide a digital input sensing of the fire alarm system to provide a trigger which shall cause ducking of all audio allowing the fire alarm annunciation in the area to be heard.
- L. The systems shall provide stereo line level output to their associated Dining Area audio visual systems allowing distribution of any audio to those areas for overflow capability.

1.3 PRODUCTS INCLUDE

- A. Products include, but are not limited to,
1. Audio

- a. Microphones and related hardware
 - b. Audio player
 - c. Digital Signal Processor
 - d. Amplifiers
 - e. Speakers
 - f. Hearing Assistance
 - 2. Video
 - a. Owner provided Projector
 - 3. Control
 - a. Control Station
 - 4. Connectivity
 - a. Cabling
 - b. Wireless AV Extenders
 - c. Receptacle Stations
 - d. Bluetooth and Auxiliary I/O
 - 5. Hardware
 - a. Equipment cabinet
 - b. Power Distribution Unit
 - c. Grounding
- B. Refer to the Drawings for additional information and requirements
- C. While due diligence has been exercised to provide multiple product manufacturers for devices and/or equipment, some components, to assure interoperability and/or compatibility, may be a single name specification. Where these items occur, the Contractor shall provide the device as specified without substitution. Should the Contractor wish to provide an alternative device for a single named product, they shall supply a formal product substitution as defined elsewhere in These Documents. This substitution request shall provide all system wide substitutions required to assure all required inter-compatibility and functionality as expressed and/or implied by the intent of the design indicated in These Documents. Such substitutions shall only be acceptable after thorough review and approval by the Engineer. Should the engineer deem a component to be unacceptable, all substitutions within that request shall be deemed unacceptable in the context of that request. Substitution requests shall be made as far in advance as possible to provide the Engineer sufficient time for review. Should insufficient time be available for review to affect bid submission, the Contractor shall provide Materials as specified.

1.4 RELATED DOCUMENTS

- A. Related Standards: All requirements of the latest published editions of the following standards and/or codes shall apply, unless otherwise noted. In the event of conflict between cited or referenced standards, the more stringent shall govern.
- 1. ANSI/INFOCOMM IM-2009 Audio Coverage Uniformity
 - 2. ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification Guide
 - 3. AVIXA F501.01:2015 Cabling Label for Audiovisual Systems
 - 4. AVIXA F502.01:2018 Rack Building for Audiovisual Systems
 - 5. RP C303.01:2018 Recommended Practices for Security in Networked Audiovisual Systems
 - 6. NFPA 70 - National Electric Code (NEC)
- B. Related Sections

1. Section 27 01 00 – Communications Common Work Results
2. Section 27 05 24 – Technology Firestopping
3. Section 27 05 26 – Grounding and Bonding for Communications Systems
4. Section 27 05 28 – Pathways for Communications Systems
5. Section 27 05 36 – Cable Trays for Communications Systems
6. Section 27 11 00 – Equipment Room Fittings
7. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
8. Section 27 15 13 – Communications Copper Horizontal Cabeling
9. Section 27 41 16 – Classroom AV System
10. Section 27 41 17.2 – Dining Area Audio Visual Systems
11. Section 27 41 17.3 – Vocal and Music Room Audio Visual Systems
12. Section 27 41 17.8 – Miscellaneous Audio-Visual Devices and Systems
13. Section 27 51 23 – Central Sound and Paging

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Bidder Qualifications: To ensure the chosen bidder has the long-term interests of Owner in mind, the following shall be required to submit at bid time for this project. Failure to submit acceptable responses to any/all requirements shall be sufficient reason to eliminate a bidder from consideration. The Owner, in its sole discretion, shall reserve the right to waive any or all the requirements listed below on an individual basis.
 - a. Bidder shall have a history of completing projects of like size and complexity for a minimum of 5 years.
 - b. Bidder shall provide a list of a minimum of three (3) facilities (facility, contact name, title, address, and current phone number) where the bidder has provided equipment and services of equivalent brand, size and scope within the last 3 years
 - c. Bidder shall provide a minimum of one (1) facility (facility, contact name, title, address, and current phone number) where the bidder has provided equipment and services of equivalent brand, size and scope that is at least five (5) years old.
2. Manufacturer Qualifications: At least 5 years of documented experience in the production of the specified products or as approved by Owner.
3. Contractor/Integrator Qualifications: An entity that employs installers and supervisors who are trained, approved and, where available, certified by the manufacturer. Full time qualified staff personnel shall be responsible and execute all programming, configuration, and training. Subcontractors for the programming, configuration and/or training purposes shall not be acceptable, and may, at the discretion of the Owner, disqualify the bidder's bid submission.

B. General:

1. Contractor shall Install all equipment, devices and cabling in compliance with all associated Codes and Regulations, and with the highest degree of workmanship in conformance with the documented standards and industry best practices that apply to these applications.
2. Contractor shall field verify all work site conditions, including dimensions and site lines prior to submitting shop drawings.
3. As stated elsewhere in these documents, the Contractor shall be knowledgeable in and perform all installation procedures in accordance with the current release of NFPA 70, the National Electrical Code, as well as any other applicable code or regulations. Furthermore,

- all materials utilized in this installation shall be new and UL listed for the application for which it is being utilized.
4. The installation shall be neat and orderly and in accordance with the highest quality as documented in all current governing and industry standards as relating to the installation of said systems, including, but not limited to, NICET, IEEE, EIA/TIA, and BICSI.
5. All terminations and programming shall be completed by technicians trained and certified by appropriate parties, including, but not limited to, InfoComm/AVIXA and the manufacturers from whom the various components are manufactured, as well as previously experienced in completing these tasks.
6. System performance and operational expectations have been developed by using the products Specified herein. Should the bidder wish to provide, AS A VOLUNTARY ALTERNATE, substitutions for these materials whether through formal substitution during bidding, as or a cost reduction measure after Contract assignment, they shall provide the following for evaluation:
 - a. During the bidding process, the bidder shall follow defined material substitution requests as outlined in the Division 0/1 Specifications and Related Documents, provide all required materials, and in the timetable allotted,
 - b. The bidder/contractor shall be responsible to provide for review and approval, all calculations and/or performance modelling and simulations to substantiate requested substitutions. All audio performance predictions shall be created in EASE for compatibility of that software used by the design team to create the baseline model.
 - c. The bidder/contractor shall provide line-item detailed cost savings for a complete list of all items required to both provide complete uniformity of design as well as required modifications to the design to fulfill the intent of the design.
 - d. The bidder/contractor shall provide data sheets clearly indicating the proposed materials being substituted for all materials being substituted containing all pertinent and salient performance data.
 - e. The Engineer/Owner retains the right to reject proposed substitutions and require those materials, equipment and work as initially specified.
- C. Review all architectural, structural, electrical, and other project documents relative to this work.
- D. Verify all dimensions and site conditions prior to starting work.
- E. Coordinate the specified work with all other trades.
- F. Maintain a competent on-site supervisor and supporting technical personnel, acceptable to the Owner during the entire installation. Change of supervisor during the project shall not be permitted without prior written approval from the Owner. On-site supervision shall be provided by a member of the contractor's regular full-time staff who holds a current certified technology specialist - Integrator (CTS-I) as offered through AVIXA/InfoComm International. Lack of a qualified on-site supervisor as defined herein shall, at the discretion of the Owner, be deemed sufficient reason to consider in breach of the Contract.
- G. Provide all items express or implied on the drawings or in the specifications that are necessary, required, or appropriate for this work to realize a complete and fully operational system that performs in stable and safe manner.

- H. Review project documentation and continuously make known any conflicts discovered and provide all items necessary to complete this work to the satisfaction of the Owner without additional expense. In all cases where a device or item or equipment is referred to in singular number or without quantity, each such reference shall apply to as many such devices or items as are required to complete the work.
- I. Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner, without additional cost to the Owner.
- J. Regularly examine all construction, and the work of others, which may affect Contractors work to ensure proper conditions exist at site for the equipment and devices before their manufacture, fabrication, or installation. Contractor shall be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.
- K. Promptly notify the Owner in writing of any difficulties that may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable in all ways to receive this work, except for defects that may develop in the work of others after its execution.
- L. After installation, submit photographs showing cable entries and terminations within equipment racks, enclosures, and pedestals at the job site.

1.6 CONTRACTOR QUALIFICATIONS

- A. The Contractor or sub-Contractor if so, executed shall currently maintain a locally run business within a 100-mile radius for a minimum of five years, and shall be an authorized distributor and service center for the supplied equipment having full warranty privileges.
- B. The Contractor or sub-Contractor if so, executed shall maintain at his facility the necessary spare parts in the proper proportions as recommended by the equipment manufacturer to maintain and service the equipment being supplied. These facilities and inventory shall be made available for inspection by the Engineer.
- C. At the time of bid submission, the Contractor or sub-Contractor if so executed shall have manufacturer specific certifications, with regard to programming, installation, troubleshooting and servicing, for the system components being provided, in particular certifications for the Digital Signal Processors, Digital Mixing Consoles and Amplifiers, as well as an Infocomm Certified Technology Specialist – Installer (CTS-I) who shall act as the on-site foreman, and an Infocomm Certified Technology Specialist – Designer (CTS-D) who shall act as on staff engineering support. Furthermore, all Dante programming and configuration shall be performed by an Audinate Level 2 Certified technician.
- D. The Contractor or sub-Contractor if so, executed shall have a minimum of five installations of like magnitude and complexity within the last three years.

1.7 SUBMITTAL REQUIREMENTS

- A. Contractor shall be required to provide submittals and shop drawings to Owner within twenty (20) calendar days of date of award notice, acknowledged with a binding letter of intent. Contractor shall be responsible to ensure that the dimensions and specifications of each component and all systems fit within the building allowances. The Owner, Architect and Engineer must review and approve all submittal documents prior to the start of work. Contractor shall advise the Owner of any discrepancy that could affect installation. If Contractor fails to notify Owner of any discrepancies, Contractor shall assume responsibility for providing the required equipment or correcting such discrepancies at no additional cost to Owner.
- B. Submittals that are incomplete, deviate significantly from the requirements of the Contract Documents, or contain numerous errors will be returned without review for rework and re-submittal, and may result in back charges to the contractor
- C. Approval of submitted items indicates only the acceptance of the manufacturer and quality. Specific requirements, arrangements, and quantities shall comply with the intent of the Contract Documents as interpreted by the Owner unless specifically approved in writing
- D. Submittals shall be provided digitally in PDF electronic file format and include Contractor's approval.

1.8 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Provide a complete LIST of proposed equipment with reference to its corresponding specification paragraph number or equipment title in specification paragraph order. Where multiple devices can utilize the same product data sheet, provide individual submissions for each device specifically hi-lighting or otherwise making the specific selection obvious to the reviewer that information which specifically applies to the device for which the submission is being provided.
 - 2. Provide preparation instructions and recommendations.
 - 3. Provide storage and handling requirements and recommendations.
 - 4. Provide installation methods.
- B. Shop Drawings: For all speakers, speaker clusters, equipment racks and related equipment.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include detail drawings of all custom fabricated items and approved equipment modifications.
 - 3. Include complete parts lists, schematic diagrams, and all dimensions required for proper assembly.
 - 4. Include component weight and power calculations.
 - 5. Include point-to-point wiring diagrams from initial signal source to final signal destination and typed wire schedule identifying every connection and cable utilizing an Owner approved cable identification scheme. Include in schedule cable type and gauge. Include all intermediate electronic devices such as all electronic components, transceivers, switches, transformers and terminal blocks. Indicate locations of all components. Identify cables by type, color, and cable identification.
 - 6. Submit conduit riser diagrams showing required conduits and junction boxes along with fill including types and quantities of cables to be contained in each conduit. Where existing

pathways are utilized indicate such re-utilization and restate the specifics of that pathway as to size, etc. as well as any current contents of pathway. Show details of weatherproofing, lightning protection and grounding, strain relief and cable support, fire stop protection, and wall penetrations through all rated partitions.

7. Submit rack layouts indicating the proposed arrangement of mounted equipment including power junction box location. Rack layouts shall be dimensionally accurate and include front and rear views.

1.9 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Manufacturer and Installer

1. Submit a list of all lower tier subcontractors and suppliers. List shall include lower tier subcontractor's qualifications indicating performance of similar work on past projects of this type and scope, as well as indicating any special certifications associated with said work; e.g. submit a copy of the certification(s) held by the party responsible for the termination and testing of the fiber optic system. The Owner reserves the right to reject any subcontractors without reservation or cause and shall have the final authority on such rejections.

B. Product Test Reports: For each type of equipment, for tests performed by a qualified testing agency.

C. Product Certificates: For each type of equipment.

D. Project Schedule: Outlining equipment delivery dates and installation start and finish dates. Project schedule shall be broken down into sufficient detail (work task and duration) to permit Owner to monitor installation progress on a daily basis. Include required approval dates by Owner/Architect.

E. Field quality-control reports.

F. Sample Warranty: For all manufacturer's special warranties and system warranties.

G. Copies of all required business and contractor licenses.

H. Proof of Insurance

1.10 CLOSEOUT SUBMITTALS

A. In addition to any close-out requirements that may defined elsewhere in these Documents, when the installation is substantially complete including the Testing Reports in Part 3 of this Section, Contractor shall submit two (2) complete initial hard copy sets of the closeout submittals as listed below to the Owner and Engineer for review and approval. After review and approval of initial set, Owner shall return one (1) initial hard copy to Contractor with comments for updating. Contractor shall provide four (4) final sets of closeout submittals to Owner and one (1) electronic copy in PDF format. Closeout submittals shall include, but not be limited to:

1. Project Record Drawings (As-Built Drawings) including, but not limited to:
 - a. electrical drawings,
 - b. device and equipment schedules,
 - c. system block diagrams,
 - d. system wiring diagrams,
 - e. rack layout drawings,
 - f. custom fabricated signage drawings (final fabrication version)

- g. testing and commissioning data formalized into a report format
2. An Operation and Maintenance Manual.
3. Full documentation of all programming provided, including, but not limited to, initial configurations settings and system presets or other operational settings in a robustly commented pre-compiled format, or for those pieces of equipment programmed through a graphical programming interface full graphic configuration with a types listing of any calibrations or settings input for any graphic element not explicitly listed in the graphic.
4. Provide two (2) copies of electronic backups of all programming and configuration executed.
5. A schedule of all equipment provided and its location within the facility. List shall include manufacturer name, model identifier, serial number, firmware versions and any other pertinent information needed to obtain service, maintenance, and/or replacement.
 - a. For all devices and equipment utilizing an Ethernet based transport, include the MAC addresses.
 - b. For all devices and equipment that utilize TCP/IP routing protocol, include the internet protocol addresses.
 - c. For all devices and equipment that utilize any other addressable protocol(s), include the names, addresses and/or any other unique information utilized to track and/or communicate with the devices or equipment.
6. Provide a list of ALL passwords for programming, administration and control features and functions for all hardware and software. Submission of the form to be included shall be sufficient for the engineering review copy of this document, as it will only be necessary to provide the passwords to the Owner.
7. Provide three (3) sets of all keys for each locked piece of equipment.
8. A list of all Subcontractors who performed work for Contractor during installation. List shall include company name, physical company address, phone number, and contact person(s), as well as the scope of work provided by the subcontractor.
9. Documentation certifying old equipment and associated support structures that were demolished by Contractor prior to the installation of new equipment have been properly disposed or recycled per local, provincial, and/or federal law(s).
10. Test reports from an independent testing & inspection agency certifying that bolted and/or welded connections for primary and/or secondary structural steel meet the minimum requirements of the engineered structural drawings, the governing building code, or as required by the building official; whichever is more restrictive.
11. All testing and commissioning reports as specified in Part 3 below.
12. Warranty Documentation, including, but not limited to, specific warranty verbiage from the various manufacturer, durations for each device covered, as well as start date(s), and copies of any/all documents submitted to the manufacturer on behalf of warranty commencement.

1.11 OPERATION AND MAINTENANCE MANUAL

- A. Upon substantial completion and prior to onsite training with the Owner, Contractor shall provide four (4) final hard copies and one electronic copy Operation and Maintenance Manuals (O&M Manuals).
- B. Electronic files shall be in .pdf format, except for drawings which shall be in .DWG format, and programming files which shall be in the native format of the programming software within which it was created pre-compiled a heavily commented.

- C. O&M Manuals shall have tab dividers and shall be logically organized to provide easy access to information without the need to research through entire manual.
- D. All documents provided in the O&M Manual shall be written in English and shall provide sufficient detail as to be understood by an individual with no knowledge of LED displays or the associated control equipment and/or operating systems.
- E. Contents of the O&M Manual shall include, but not be limited to:
 - 1. Table of Contents
 - 2. Description of system(s) including key features and operational procedures.
 - 3. Full start up procedure for all equipment written under the assumption that all equipment was in full powered off mode.
 - 4. Full shutdown procedure for all equipment written under the assumption that the facility is in fully powered up use
 - 5. Troubleshooting procedures for DSP's, amplifiers, Dante network devices and equipment, and all related equipment provided by Contractor. Troubleshooting procedures shall include demonstration photos and/or diagrams as required.
 - 6. Maintenance procedures for DSP's, amplifiers, Dante network devices and equipment, and all related equipment provided by Contractor. Maintenance procedures shall include demonstration photos and/or diagrams as required. Contractor shall indicate whether maintenance procedures should be performed monthly, bi-annually, or annually.
 - 7. Owner's Manuals for all third party and/or "off the shelf" type equipment provided by Contractor; e.g., KVM's, fiber modems, network switches/routers, and UPS battery back ups
 - 8. All third-party equipment and/or "off the shelf" equipment warranties and a notarized System Warranty.
 - 9. Instructions for alternative control operations for intramural or other non-game day use by untrained university staff.
 - 10. Hard copy listings and electronic copies transferred to a USB connected mass storage device of all programming code and configuration software data files in a pre-compiled format capable of being opened and modified in the standard software utilized to do the initial programming.

1.12 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products in strict compliance with the manufacturer's instructions and recommendations, as well as industry standards.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store materials within absolute limits for temperature and humidity recommended by manufacturer. Protect from damage.

1.13 SEQUENCING

- A. Ensure that information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress. Coordinate with the General

Contractor for the associated infrastructure bid package to assure effective and complete installation of work.

1.14 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results.
- B. Verify field measurements prior to commencement of work.
- C. Do not install products under environmental conditions outside manufacturer's absolute limits.
- D. Do not install suspended products and/or products located on the catwalk until contractor responsible for any/all structural modifications has completed work impacted by such additions of weight and/or structural stresses.
- E. Products shall not be installed until painting and other finish work is complete.

1.15 WARRANTY AND SERVICE

- A. Contractor shall warrant all labor and materials for twenty-four (24) months following the date of Final Acceptance.
- B. During the warranty period the system shall be free of defects and deficiencies and conform to the drawings and specifications with respect to the quality, function, and characteristics stated.
- C. Contractor shall repair or replace all defects that occur in labor or materials within the warranty period. On-site labor shall be included during the warranty period. Any/all warranty replacements and repairs shall not lessen or terminate subsequent warranty for all material and labor for the entirety of the system including those materials either repaired or replaced.
- D. Failed parts whose replacement is performed without onsite intervention by the Contractor shall be returned to the Contractor for repair at a service facility located in the United States. Contractor shall identify the location of its service facility in the documentation provided when submitting a bid for this work.
- E. The Contractor shall replace failed parts that cannot be repaired.
- F. Upon receipt of a failed part, Contractor shall return a repaired or replacement part to the Owner within fifteen (15) business days from receipt of failed part. Replacement parts shall be new, or like new and operational as if new.
- G. The Contractor shall be responsible for providing the following emergency response availability:
 - 1. Telephone service assistance and technical support for problem diagnostics and programming/operational issue resolution.
 - 2. A parts exchange program, including advance parts replacement via same day shipment. The manufacturer shall keep a ready stock of key assemblies available to ship out upon notice of a parts failure if part is not available in spare parts inventory at Owner's facility.
 - 3. During the warranty period all devices and equipment necessary for the ongoing operation of

the scoreboard shall be available to be provided as an advanced replacement. The advance replacement should contain all of the shipping information and packaging necessary to return the defective part or assembly back to Contractor at no cost to the Owner.

- H. The Contractor shall supply at least one local service employee or local authorized service agent for servicing and repair of all equipment during the warranty period. Local service employee or local authorized service agent shall be located within 200 miles of Owner's facility.
- I. The local service employee or local authorized service agent shall, when required, provide on-site support within 24 hours of notification.
- J. The local service employee or local authorized service agent shall maintain at their office/service depot a stock of the most common components that may require replacement. The stock shall be maintained and shall be eligible as previously define in this Section as advance replacement stock. And, when necessary, shall act as same with the manufacturer replenishing their local service stock instead or requiring a second site visit and system replacement.
- K. Warranty shall cover all equipment, including processors, controllers, operating systems, and software.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

- A. As indicated elsewhere in These Documents, the products specified on these Construction Documents are to be furnished as indicated. Any deviation from the use of materials or products shall be handled in accordance with terms and conditions established elsewhere in These Documents. Where substitutions are not previously approved in writing by the Engineer, they shall be deemed unacceptable.

2.2 PRODUCTS

- A. All products shall be new, UL listed and comply with all applicable Federal, State and Local regulations. B Stock items are not allowed.
- B. Audio
 - 1. Microphones
 - a. Wireless
 - 1) Performance Metrics:
 - (a) Dynamic Range: >115 dB A weighted, typical
 - (b) Output: XLR Balanced +14 dBV minimum
 - (c) THD: <1.0%, 1kHz, ±17.5 kHz
 - (d) Modulation: FM
 - (e) Operating Sensitivity: 20dBuV @ 60dBA SNR
 - (f) Channel Config:
 - (1) 40 Channels/band minimum, Frequency Agile
 - (2) 25 kHz Channels

- (g) Spectrum: UHF, coordinate availability in band with local licensing and conditions
 - (h) Operating Range: 100m, open field
 - 2) Receivers:
 - (a) ATW-3211 Series (470-530 MHz) – Provide 4
 - 3) Handheld
 - (a) ATW-T3212 Series (470-530 MHz) – Provide 2
 - (b) ATW-C510 Cardioid Dynamic Microphone Capsules – Provide 2
 - 4) Headworn
 - (a) ATW-T3201 Body-Pack Transmitter – Provide 2
 - (b) BP-894 MicroSet Cardioid Condenser Headworn Mic – Provide 2
 - 5) Antenna System
 - (a) Remote antennas to within the room serviced
 - (b) Provide cabling and combining system as provided by the microphone system manufacturer to provide complete coverage of the entire space
 - 6) Charging System
 - (a) As manufactured by the manufacturer of the microphone system. Provide either individual chargers or multiple charger units for 100% of the battery powered devices being provided.
 - 7) Manufacturers and Series
 - (a) Audio Technica 3000 Series,
 - (b) Equivalent product by: Shure, Sennheiser
 - b. Microphone Stands
 - 1) Floor Stand
 - (a) Adjustable 36" – 60" chrome stand with 10" diameter round base, rubber feet, and minimum 9 pound weight – Provide 2
 - 2) Table Top
 - (a) Adjustable 9" – 13" chrome stand with 6" diameter round base, rubber feet, and minimum 2 pound weight
 - 3) Manufacturers
 - (a) Atlas Soundolier
 - (b) Proline
 - (c) Shure
2. Audio Player
- a. Disk Formats and File Systems:
 - 1) Disk: CD-DA, CD-ROM, CD-R,
 - 2) USB: FAT16 and FAT32
 - b. File Formats: .cda, .wav, .mp3
 - c. SNR: >90 dB (A-weighted)
 - d. Frequency Response: 10Hz – 20kHz
 - e. THD: 0.01%
 - f. Dynamic Range: > 85dB
 - g. Channel Separation: >80dB
 - h. Outputs:
 - 1) Unbalanced: RCA, >10k Ω , 2 Vrms @ 10k Ω
 - 2) Balanced: XLR, >10k Ω , +4dBu
 - i. Remote Control: IR, RS-232C, IP
 - j. Bluetooth:

- 1) Version 4.0
 - 2) Codecs: SBC, MP3
 - 3) Range: 82 ft.
 - k. File Folder Limits:
 - 1) Storage Capacity: $\leq 2\text{TB}$
 - 2) File Size: $\leq 2\text{GB}$
 - 3) File Name Length: ≤ 255 Characters
 - 4) Number of Files: $\leq 999/\text{Folder}$
 - 5) Number of Folders: ≤ 999
 - 6) Number of Folder Levels: ≤ 8
 - l. Manufacturer and Model:
 - 1) Denon-700CB, equal by Tascam or Yamaha
3. Digital Signal Processor
 - a. Fixed preconfigured I/O configuration
 - b. Input: 12 mic/line (minimum)
 - c. Output: 8 mic/line (minimum)
 - d. GPIO: 4 channel (minimum)
 - e. Frequency Response; 20 Hz to 20 kHz, +4 dBu output: +0.25 dB/-0.5 dB
 - f. THD+N (22 Hz to 22 kHz)
 - 1) 0dB Gain, +4 dBu input: $<0.006\%$
 - 2) 54 dB gain, -50 dBu input: $<0.040\%$
 - g. Dynamic Range; 22 Hz to 22kHz, 0 dB gain: $>108\text{ dB}$
 - h. Input Impedance (Bal): $8\text{k}\Omega$
 - i. Output Impedance (Bal): 207Ω
 - j. Max input: +24 dBu
 - k. Max Output: $\pm 24\text{ dBu}$, +18 dBu, +12 dBu, +6 dBu, 0 dBu, -31 dBu selectable
 - l. Input Gain Range: 0-66dB (6 dB steps)
 - m. Sampling Rate : 48 kHz
 - n. Processor programming configurable through GUI programming interface
 - o. Network Connectivity: Gigabit Ethernet
 - p. Remote control: Ethernet
 - q. Basis of Design:
 - 1) Biamp Forte AI
 - 2) Equivalent Product by: QSC or Extron
4. Amplifiers
 - a. Configuration: 8 Ch
 - b. Sensitivity: 1.4V
 - c. Power Output: 600W/Ch
 - d. Input Impedance : $>20\text{k}\Omega$
 - e. Output : 70V
 - f. Frequency Response : 20 Hz – 20 kHz
 - g. THD $<0.5\%$ @ 1KhZ
 - h. SNR 100 dB, 20 Hz – 20kHz
 - i. Processing : Integrated DSP
 - j. Manufacturer
 - 1) Crown, LEA, QSC
5. Speakers:
 - a. Configuration: Two way 12" LF Driver, 1" HF Driver

- b. Nominal Dispersion Pattern: 90°H x 40°V Max
 - c. Frequency Range: 85 Hz – 16 kHz
 - d. Power Handling: 200W continuous @ 8Ω
 - e. Output: 126 dB continuous, 132 dB Peak
 - f. Sensitivity: 103dB 1W/1M
 - g. Mount: Hardware as recommended by Manufacturer
 - h. Finish: White, Uniformly textured
 - i. Manufacturer and Model
 - 1) Community R.5-94Z, equal by JBL, QSC
 - 6. Hearing Assistance System
 - a. Frequency Response: 50 Hz – 15 kHz
 - b. SNR: 50 dB minimum
 - c. Input: XLR-F, balanced, -55 dBu mic level, 20kΩ impedance
 - d. THD: <2%
 - e. Technology: RF
 - f. Spectrum: VHF
 - g. Transmitter Output Power: 100 mW
 - h. Range: 3000 ft., open field
 - i. Components:
 - 1) Transmitter: Stationary: Provide 1
 - 2) Rack Mount Kit: Provide 1
 - 3) Antenna Kit: Provide 1
 - 4) Assistive Listening Notifications Signage Kit: Provide 1
 - 5) No receivers, ear buds or induction loops required, as this system will use those provided under the scope of the Stadium System
 - j. Manufacturers
 - 1) System shall match and be compatible with that which is being provided for the stadium.
- C. Video
 - 1. Owner provided projector
- D. Control Station
 - 1. Control station shall be Ethernet based and designed by the DSP manufacturer to connect to and control all aspects of the DSP.
 - 2. Control station shall support a 12-button touch screen capability.
 - 3. Control station brightness shall be automatically adjust for ambient light level
 - 4. Control station shall have a visual indicator that shall show the system state and status of audio mute.
 - 5. Control station shall be powered by standard Power over Ethernet
 - 6. Control station shall be CE marked, UL listed and RoHS compliant
 - 7. Control station shall be as manufactured by and compatible with the DSP system provided.
 - 8. Power shall be provided as required.
 - 9. Acceptable Manufacturer and Model:
 - a. Bi-amp TEC-X 2000, Equal by QSC or Extron
- E. Connectivity
 - 1. Cabling
 - a. All cabling shall be new and UL listed.
 - b. Microphone
 - 1) All microphone cable shall be 22 AWG stranded copper wire.

- 2) All microphone cable shall be low capacitance.
 - 3) All microphone cable shall have a continuous foil shield with drain conductor.
 - 4) Acceptable Manufacturer and Model shall be:
 - (a) West Penn D25291 plenum and 77291 for non-plenum
 - (b) Or equivalent product by Liberty Wire and Cable or Belden
 - c. Speaker
 - 1) All speaker cable shall be 12 AWG stranded copper wire.
 - 2) Acceptable Manufacturers
 - (a) West Penn: 25227 plenum
 - (b) Or equivalent product by Liberty Wire and Cable or Belden
 - d. Patch Cords:
 - 1) Provide all indicated or as may be required for complete connection of all system components
 - 2) All terminations shall be tinned with solder prior to termination, and solder to their connector where the means of connection can withstand such process.
 - 3) All patch cords for network connections shall comply with Section 27 15 13 Communications Copper Horizontal Cabling, and match the manufacturer provided under the structured cabling scope of work.
 - 4) All audio patch cords shall match the gauge of the cabling being provided for the balance of the cabling run, and be terminated with a mechanical means assuring disconnection and reconnection consistency.
 2. Wireless AV Extenders
 - a. Compatible with Windows, MAC, iOS and Android
 - b. Wireless Point to Point connection.
 - c. Capable of receiving video with a minimum of 1080p/60 with stereo audio.
 - d. Provides a canvass capable of concurrently up to 4 simultaneous video inputs.
 - e. Compliant with HDCP 2.3.
 - f. Acceptable Manufacturer and Model:
 - 1) Barco Clickshare CX-20, Extron eLink 100, Crestron AM-200
 3. Receptacle Stations and Related Hardware
 - a. Standard Faceplates: Brushed Aluminum, as manufactured by ProCo, Panelcrafters/Liberty A/V or Switchcraft.
 4. Bluetooth Receiver: Attero Tech UNBT2A with AXP20 Receiver
 5. Transformer: For transforming constant voltage paging from the local zone to line level for input into the audio system.
 - a. Radio Design Labs, TX-70A
 6. Projector Audio Extension: Provide transmitter and receiver as defined by the wireless microphones above. Integrate antenna and frequency into and with the wireless microphone system
- F. Hardware
1. Equipment Cabinet
 - a. Black electrostatic finish
 - b. EIA 19" Rack mount front and rear rails, 10x32 drilled and tapped with visible RU indicator
 - c. 16 Rack Units high
 - d. Three section
 - e. 22.3" Deep
 - f. Front and Rear locking

- g. UL Listed 1678
- h. 14 gauge frame, 16 gauge side frame, 14 gauge top and bottom sections
- i. Provide 3U drawer with customizable foam insert.
- j. Provide lacing brackets vertically at both back corners, and a lacing bar per each component mounted in the cabinet.
- k. Acceptable Manufacturer and Model:
 - 1) Middle Atlantic DWR-16-22
- 2. Power Distribution Unit
 - a. PDU shall be horizontal, rack mount, 15A 120V
 - b. PDU shall provide three duplex receptacles that shall power up and down per safe sequence to protect the equipment in the cabinet, plus one duplex that is non-switched.
 - c. PDU shall have all connections rear mounted.
 - d. PDU shall be controllable by a minimum of a discrete closure from the control system, RS-232 control acceptable.
 - e. Provide 1 per cabinet
 - f. Acceptable manufacturer and model:
 - 1) Furman M8-S
- 3. Grounding
 - a. 19" x 1/2" horizontal ground bar as provided the cabinet manufacturer.
- G. Miscellaneous Hardware
 - 1. Provide any/all hardware and accessories required to complete the design intent provide, as well as may be required to comply with any/all applicable codes, audiovisual industry standards and best practices, and to assure a safe operational environment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall neatly label and dress all cabling to assure easy maintenance and troubleshooting. Within all equipment enclosures, including but not limited to, video equipment racks, the Contractor shall utilize Velcro straps or Milli-Tie wraps for bundling of signal wires. Within all enclosures provide and utilize lacing bars and surfaces to assure neat and trouble-free system operation and maintenance.
- B. All cabling labeling shall be by means machine generated labels that wrap the complete cable diameter. Adhere labels within 6" of each end of the cable ends. Label all speaker cabling at the rack end with the specific speaker ID. Label all speakers at the speaker end with both the speaker ID and the amplifier ID.
- C. Label all components with the device name derived under Paragraph 3.2 below. Labels shall be machine generated on a self-adhesive tape or phenolic engraved tag.
- D. Rack and stack all cabinets, and/or clusters of equipment in the Contractor's shop in a controlled environment. Verify that the completed cabinets, and/or equipment cluster operates properly prior to transporting the cabinets and/or equipment clusters to the job site for final assembly.
- E. After assembly of the system on site, execute all required programming, calibration, and commissioning to optimize performance of the system within the constraints of the installed

environment.

- F. Mount all speakers and other components as either specified or drawn, or for cases where explicit instructions are not given within these Documents, execute all installation to the highest level of industry best practices. After installation of these speakers and other devices are completed, verify all mechanical and electrical connections are executed per recommended by the device manufacturer, and all items are safe and secure.
- G. Fully test the system for component operation, as well as project specific programming. Document the testing procedures and the results of the testing. Submit hard copy of the testing documentation in the Operations and Maintenance Manuals submitted at time of close out.
- H. Equipment Racks
 - 1. The Contractor shall submit to the Engineer for approval, the intended cabinet layouts, prior to installation. Upon written approval of the cabinet layouts the Contractor may proceed with this installation.
 - 2. Cabling shall be routed, combed, and bound neatly as it is routed in the cabinet. Orderly cable bundles shall be grouped and secured to the cabinet structure. Cables shall be provided with enough service loop to enable the contractor to route all cabling up the sides of the cabinet to the height of the device to be connected, and then over to that device.
 - 3. Failure to comply with this requirement shall give the Owner or Engineer the option to require the Contractor re-dress the cabling or remove it in whole and re-install the cabling.

3.2 PROGRAMMING and CONFIGURATION

- A. Unless otherwise directed by the District IT staff, all network devices shall be assigned permanent IP addresses. These addresses shall be coordinated with Owner's IT personnel. The Contractor shall then program all devices with these IP addresses and inventory. Document all MAC addresses, manufacturers, model numbers and serial numbers. Include all assigned IP addresses in the aforementioned documentation. Include both hard and electronic copies in the Operations and Maintenance Manuals submitted at time of close out.
- B. All devices having the ability to program names shall be programmed with meaningful names. Coordinate the naming convention with the Owner prior to programming. Include a schedule of the devices and the corresponding names in the Operations and Maintenance Manuals submitted at the time of close out.
- C. Program the mixer channels with user friendly names consistent with the naming convention previously mentioned. Program the DSP utilizing the same user-friendly names.
- D. Program the internal DSPs of each amplifier with the proper characteristic parameters unique to the speakers being installed.
- E. Equalize and tune the system to provide optimum performance of all components and the complete system. Equalize and time alignment all speakers. Equalization and time alignment shall be programmed within the system DSP, not the mixers or the amplifier's processing.

- F. Calibrate the signal chain's gain structure to maximize the dynamic range of the system. Adjust the gain structure to a threshold just below clipping and to provide a minimum of 14dB of headroom.
- G. Program the systems for:
 - 1. System On/System Off
 - 2. Source-select for individual volume control
 - 3. Master Volume control
- H. While both project specific and general best practice procedures for programming and operations have been explicitly indicated herein, provide all required programming and configuration to fully realize the intent of the design.

3.3 LABELING

- A. All wires and cables shall be labeled with either a self-laminating label designed for labeling wire and cable, or by wrapping a pre-printer or computer-generated label designed by the manufacturer for this purpose, and by sealing it with clear heat shrink tubing over the entire label.
- B. Failure to comply with this requirement shall give the Owner or Engineer the option to require the Contractor re-dress and re-label the cabling or remove it in whole and re-install and re-label the cabling.

3.4 GROUNDING

- A. This rack shall be bonded back to the nearest available TELECOMMUNICATIONS BUSBAR with a minimum #6 AWG bonding conductor, utilizing a two-hole irreversible lug at both ends of the conductor. Each cabinet or rack shall have an individual homerun bonding conductor. Daisy chaining of the bonding conductor is unacceptable.

3.5 CALIBRATION AND COMMISSIONING

- A. System Commissioning, including testing and certification of system performance, shall be completed by a factory certified/authorized representative prior to final payment. Said representative shall be fully certified by the manufacturer, and not simply an employee of the Contractor relying upon the Contractor's company certifications. All system operation or installation deficiencies and resultant corrective actions shall be documented and submitted to the Owner at time of commissioning and shall be resolved prior to final training and final payment. Final payment shall be held until such time that final commissioning and training is completed to the satisfaction of the Owner and Engineer.
- B. All installation and calibration of equipment shall be by qualified and certified personnel. All calibrations shall be checked by appropriate calibration equipment. Calibrations made simply by authoritative and/or experienced eyes and/or ears are not acceptable.
- C. Test all cables prior to termination. Cabling having industry recognized standardized testing procedures, above basic continuity, and other simple testing, shall be tested utilizing test devices designed for said tests.

- D. All test and measurement devices and equipment that are designed to be calibrated, shall be calibrated by a NIST certified process/test facility no more than one year time prior to use. This threshold shall be shorter where recommendations either by the device/equipment manufacturer or industry best practices recommend more frequent calibration for optimum results.
- E. Turn on, and individually test all components to assure the individual component or device is operating within normal operational parameters, prior to assembling them into the larger system.
- F. Document all calibrations and adjustments in machine generated print in a neat and organized fashion for transmission to the Owner. Include any/all test and measurement device and equipment reports in human readable format. The Engineer reserves the right to review, reject or require modification or further documentation prior to completion of the project.
- G. Unless otherwise recommended by industry acknowledged best practices or standards for this application, calibrate the system to provide a unity gain structure through the signal path. Where said best practices or standards would indicate other than this gain structure, provide documented procedures and expected results as to the alternative method to the Engineer for review and approval prior to execution. Do not proceed with these alternative calibrations without the prior written approval of the Engineer.
- H. The Engineer shall be given the opportunity to monitor, and as may be needed participate in, the calibrations and commissioning. The Contractor shall apprise the Engineer two weeks prior to commencement of said calibrations and commissioning to facilitate effective scheduling of the Engineer's time to attend same. Should such courtesies not be extended to the Engineer prior to the final calibrations and commissioning, the Engineer reserves the right for the procedures to be completely repeated prior to considering job completion.

3.6 WORK COMPLETION

- A. The Contractor shall provide a complete and functioning system, based on the intent of the designs as set forth in these Documents. Any/all equipment, either implied or intentionally omitted from these documents, but generally accepted as being required for the completion of the installation, as represented in these Documents, shall be provided by the Contractor at no additional cost to the Owner.
- B. The Contractor shall provide a copy of all test results, programming, or other documentation to the Engineer for review and approval prior to Owner acceptance.
- C. The Contractor shall provide all recommended fixed and flexible wire management to achieve a high-quality installation both visually and operationally, and that would be considered within the standard practices of good workmanship. The Contractor shall speed wrap all loose cables routed between end devices and their associated destination such as between a projector and the associated faceplate, or between the cabinets and enclosures, and the associated faceplate and ancillary devices.
- D. Demonstrate the fully functional system to the Engineer and Owner prior to training or job completion to assure compliance with the design intent.

- E. Complete ALL punch list items provided by the Engineer prior to submission for substantial completion.
- F. Create electronic backup files of configurations and other programming for each of the preset operations. Record same onto electronic storage media. Make 3 copies of same. Provide these copies to the Owner at the point of system acceptance. Should system acceptance extend past the expected point of facility substantial completion, provide interim copies for the Owner prior to first use of the systems(s).
- G. Complete training as prescribed elsewhere in these Documents.
- H. Submit close out documentation for review and approval by the Engineer prior to Substantial Completion or processing of O&M manuals through the construction process to the Owner. Correct any/all issues cited by the Engineer prior to submission to the CM for release to the Owner.

3.7 TRAINING

- A. The Contractor shall perform formal training with permanent staff personnel under the employ of the Owner. Such training shall last a minimum of 2 hours.
- B. At the time of training, the Contractor shall obtain a sign in sheet that shall be copied with one copy being kept on file by the Contractor, and one copy being forwarded to the Owner. The sign in sheet shall at a minimum contain the following information:
 - 1. Date
 - 2. Time
 - 3. Location of training
 - 4. Name of system on which trained
 - 5. Name, organization, department, role, E-Mail address and phone number of each participant.
 - 6. The signature of the trainer
 - 7. A copy of the approved itinerary
- C. The training shall be video captured in a minimum of 1080p resolution in a standard digital format capable of viewing on a standard computer running current releases of Windows, Mac or Linux. The subsequent video shall be recorded on to a USB connected storage device. The Contractor shall provide four copies of the USB connected storage device, one for each copy of the Operations and Maintenance manuals.
- D. All costs associated with these training requirements, including, but not limited to the supplemental trainings and their associated travel, shall be included in the base bid costs of the Contractor, and shall garner no additional reimbursements or funds.

3.8 WARRANTY

- A. Warranty of the system, including parts and labor, shall be by the system supplier and manufacturer for all materials and workmanship for a period of no less than two (2) years, or for the duration of the manufacturer's documented warranty whichever is greater. Should for some unforeseeable reason, the installer not be able to complete the term of the warranty, the manufacturer shall bear the complete responsibility of the warranty for both parts and labor and shall appoint a certified service organization to complete the term of the warranty. The manufacturer shall inform the Owner of this

appoint in writing. The Contractor shall present assurance of this stipulation from the Manufacturer to the Owner in writing prior to commencement of work. Should the Contractor not provide this written assurance, the Owner shall retain the right, as outlined elsewhere in these Documents, to obtain satisfaction, including but not limited to, financial restitution to the Owner.

END OF SECTION 27 41 17.1

SECTION 27 41 17.2 - DINING AREA AUDIO VISUAL SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Work in this Section includes, but is not limited to, furnishing, and installing fully integrated audio-visual systems in the in the Student Dining Area.
- B. This Section and the associated Drawings and Diagrams convey the intent of the design. The system(s) shall be provided in its entirety to provide a complete and working system(s) as expressed by this intent. Items drawn but not specified or specified but not drawn shall be provided as if included in both. Furthermore, it is incumbent on the Contractor to provide any device(s) required to make the system(s) fully functional to the intent of the design, whether indicated or not.
- C. Products Supplied but not installed by the Contractor
 - 1. The Contractor shall coordinate the delivery of items that must be installed by other trades to assure timely delivery.
 - 2. The Contractor shall verify lead times of all items required under this heading. Should the delivery of such items be delayed due to the Contractor's efforts, or lack thereof, the Contractor shall bear the burden of compensation to all related trades and for any expedited handling, so as to regain any loss incurred by the project schedule.
- D. Products Installed but not Supplied by the Contractor
 - 1. It shall be incumbent upon the Contractor to verify the exact requirements of any system, device, equipment, or Materials supplied to them for installation by others. Any deviations between the Contract Documents and these requirements shall be brought to the immediate attention of the Engineer, and to the other trades as necessary.
- E. Devices, equipment, or other infrastructure installed by other contractors in support of this Contractors efforts
 - 1. It shall be the responsibility of this Contractor to coordinate with the other contractors on the project who shall be providing items such as rough-in box and conduit to facilitate this Contractor's systems and device to verify the appropriateness and location of these items.
 - 2. This Contractor shall provide any necessary guidance as to the correctness of the information being used by these other contractors. Any item(s) either being provided out of Specification, in the wrong location, or inappropriate for the application shall be:
 - a. intervened upon immediately,
 - b. communicated to the CM/GC for resolution in writing,
 - c. communicated to the Engineer for resolution.
 - 3. Should the Contractor fail to coordinate, intervene and communicate the issue(s) to the aforementioned parties, it shall be the responsibility of this Contractor to correct such issues at the sole burden of this Contractor.

Note: It is understood and acknowledged that this Contractor cannot and shall not be held accountable for items of this nature, prior to this Contractor's authorized involvement in this project.
- F. Products furnished and/or installed by others requiring integration to the system
 - 1. Products furnished and/or installed by others requiring integration to the system, e.g. Owner provided displays or projectors shall be fully integrated into the system.
 - 2. Coordinate with the provider of products.

- a. Provide all needed interconnecting cabling and connectivity.
- b. Provide all needed programming.
- c. Locate all associated devices and materials to facilitate effective integration.
- d. Coordinate with the Electrical Contractor to assure effective placement of any supporting infrastructure provided by EC.
- e. Coordinate with the General Trades to assure effective placement of backing or other materials required.

1.2 DESCRIPTION

- A. The systems shall provide audio and video playback as well as live voice reinforcement throughout the dining area.
- B. The systems shall provide audio wireless microphone capability for the voice reinforcement.
- C. The systems shall provide overhead audio for any of the video displays.
- D. The systems shall include a program playback source at the equipment cabinet.
- E. The systems shall provide Bluetooth/Aux input connectivity.
- F. The systems shall provide control of audio-visual devices by means of a control station providing source selection, individual and master volume control, as well as system/device power on and off utilizing a simple tactile user interface.
- G. The systems shall provide ADA required hearing assistance.
- H. The systems shall leverage their control system within it to power on and off based on anticipated normal hours of operation.
- I. The system shall remain active throughout normal operation to provide paging from the Central Sound and Paging System during all normal hours of operation.
- J. The systems shall provide a key-switch override for use by first responders to facilitate emergency response directions to the occupants of the space.
- K. The systems shall provide a digital input sensing of the fire alarm system to provide a trigger which shall cause ducking of all audios allowing the fire alarm annunciation in the area to be heard.

1.3 PRODUCTS INCLUDE

- A. Products include, but are not limited to,
 - 1. Audio
 - a. Microphones and related hardware
 - b. Audio player
 - c. Digital Signal Processor
 - d. Amplifiers
 - e. Speakers
 - f. Hearing Assistance
 - 2. Video
 - a. Displays
 - b. Projector

- c. Distribution Amplifier
 - d. Decoders
 - 3. Control
 - a. Control Processor
 - b. Control Panel
 - 4. Connectivity
 - a. Cabling
 - b. AV extenders
 - c. Receptacle Stations
 - d. Bluetooth and Auxiliary I/O
 - 5. Hardware
 - a. Equipment cabinet
 - b. Power Distribution Unit
 - c. Grounding
- B. Refer to the Drawings for additional information and requirements
- C. While due diligence has been exercised to provide multiple product manufacturers for devices and/or equipment, some components, to assure interoperability and/or compatibility, may be a single name specification. Where these items occur, the Contractor shall provide the device as specified without substitution. Should the Contractor wish to provide an alternative device for a single named product, they shall supply a formal product substitution as defined elsewhere in These Documents. This substitution request shall provide all system wide substitutions required to assure all required inter-compatibility and functionality as expressed and/or implied by the intent of the design indicated in These Documents. Such substitutions shall only be acceptable after thorough review and approval by the Engineer. Should the engineer deem a component to be unacceptable, all substitutions within that request shall be deemed unacceptable in the context of that request. Substitution requests shall be made as far in advance as possible to provide the Engineer sufficient time for review. Should insufficient time be available for review to affect bid submission, the Contractor shall provide Materials as specified.

1.4 RELATED DOCUMENTS

- A. Related Standards: All requirements of the latest published editions of the following standards and/or codes shall apply, unless otherwise noted. In the event of conflict between cited or referenced standards, the more stringent shall govern.
 - 1. ANSI/INFOCOMM IM-2009 Audio Coverage Uniformity
 - 2. ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification Guide
 - 3. AVIXA F501.01:2015 Cabling Label for Audiovisual Systems
 - 4. AVIXA F502.01:2018 Rack Building for Audiovisual Systems
 - 5. RP C303.01:2018 Recommended Practices for Security in Networked Audiovisual Systems
 - 6. NFPA 70 - National Electric Code (NEC)
- B. Related Sections
 - 1. Section 27 01 00 – Communications Common Work Results
 - 2. Section 27 05 24 – Technology Firestopping
 - 3. Section 27 05 26 – Grounding and Bonding for Communications Systems
 - 4. Section 27 05 28 – Pathways for Communications Systems
 - 5. Section 27 05 36 – Cable Trays for Communications Systems
 - 6. Section 27 11 00 – Equipment Room Fittings
 - 7. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
 - 8. Section 27 15 13 – Communications Copper Horizontal Cabling
 - 9. Section 27 41 16 – Classroom AV System

10. Section 27 41 17.1 – Gymnasium Audio Visual Systems
11. Section 27 41 17.3 – Vocal and Music Room Audio Visual Systems
12. Section 27 41 17.8 – Miscellaneous Audio-Visual Devices and Systems
13. Section 27 51 23 – Central Sound and Paging

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Bidder Qualifications: To ensure the chosen bidder has the long-term interests of Owner in mind, the following shall be required to submit at bid time for this project. Failure to submit acceptable responses to any/all requirements shall be sufficient reason to eliminate a bidder from consideration. The Owner, in its sole discretion, shall reserve the right to waive any or all the requirements listed below on an individual basis.
 - a. Bidder shall have a history of completing projects of like size and complexity for a minimum of 5 years.
 - b. Bidder shall provide a list of a minimum of three (3) facilities (facility, contact name, title, address, and current phone number) where the bidder has provided equipment and services of equivalent brand, size and scope within the last 3 years
 - c. Bidder shall provide a minimum of one (1) facility (facility, contact name, title, address, and current phone number) where the bidder has provided equipment and services of equivalent brand, size and scope that is at least five (5) years old.
2. Manufacturer Qualifications: At least 5 years of documented experience in the production of the specified products or as approved by Owner.
3. Contractor/Integrator Qualifications: An entity that employs installers and supervisors who are trained, approved and, where available, certified by the manufacturer. Full time qualified staff personnel shall be responsible and execute all programming, configuration, and training. Subcontractors for the programming, configuration and/or training purposes shall not be acceptable, and may, at the discretion of the Owner, disqualify the bidder's bid submission.

B. General:

1. Contractor shall Install all equipment, devices, and cabling in compliance with all associated Codes and Regulations, and with the highest degree of workmanship in conformance with the documented standards and industry best practices that apply to these applications.
2. Contractor shall field verify all work site conditions, including dimensions and site lines prior to submitting shop drawings.
3. As stated elsewhere in these documents, the Contractor shall be knowledgeable in and perform all installation procedures in accordance with the current release of NFPA 70, the National Electrical Code, as well as any other applicable code or regulations. Furthermore, all materials utilized in this installation shall be new and UL listed for the application for which it is being utilized.
4. The installation shall be neat and orderly and in accordance with the highest quality as documented in all current governing and industry standards as relating to the installation of said systems, including, but not limited to, NICET, IEEE, EIA/TIA, and BICSI.
5. All terminations and programming shall be completed by technicians trained and certified by appropriate parties, including, but not limited to, InfoComm/AVIXA and the manufacturers from whom the various components are manufactured, as well as previously experienced in completing these tasks.
6. System performance and operational expectations have been developed by using the products Specified herein. Should the bidder wish to provide, AS A VOLUNTARY ALTERNATE, substitutions for these materials whether through formal substitution during bidding, as or a cost reduction measure after Contract assignment, they shall provide the

following for evaluation:

- a. During the bidding process, the bidder shall follow defined material substitution requests as outlined in the Division 0/1 Specifications and Related Documents, provide all required materials, and in the timetable allotted,
 - b. The bidder/contractor shall be responsible to provide for review and approval, all calculations and/or performance modelling and simulations to substantiate requested substitutions. All audio performance predictions shall be created in EASE for compatibility of that software used by the design team to create the baseline model.
 - c. The bidder/contractor shall provide line-item detailed cost savings for a complete list of all items required to both provide complete uniformity of design as well as required modifications to the design to fulfill the intent of the design.
 - d. The bidder/contractor shall provide data sheets clearly indicating the proposed materials being substituted for all materials being substituted containing all pertinent and salient performance data.
 - e. The Engineer/Owner retains the right to reject proposed substitutions and require those materials, equipment and work as initially specified.
- C. Review all architectural, structural, electrical, and other project documents relative to this work.
- D. Verify all dimensions and site conditions prior to starting work.
- E. Coordinate the specified work with all other trades.
- F. Maintain a competent on-site supervisor and supporting technical personnel, acceptable to the Owner during the entire installation. Change of supervisor during the project shall not be permitted without prior written approval from the Owner. On-site supervision shall be provided by a member of the contractor's regular full-time staff who holds a current certified technology specialist - Integrator (CTS-I) as offered through AVIXA/InfoComm International. Lack of a qualified on-site supervisor as defined herein shall, at the discretion of the Owner, be deemed sufficient reason to consider in breach of the Contract.
- G. Provide all items express or implied on the drawings or in the specifications that are necessary, required, or appropriate for this work to realize a complete and fully operational system that performs in stable and safe manner.
- H. Review project documentation and continuously make known any conflicts discovered and provide all items necessary to complete this work to the satisfaction of the Owner without additional expense. In all cases where a device or item or equipment is referred to in singular number or without quantity, each such reference shall apply to as many such devices or items as are required to complete the work.
- I. Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner, without additional cost to the Owner.
- J. Regularly examine all construction, and the work of others, which may affect Contractors work to ensure proper conditions exist at site for the equipment and devices before their manufacture, fabrication, or installation. Contractor shall be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.
- K. Promptly notify the Owner in writing of any difficulties that may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable in all ways to receive this work, except for defects that may develop in the work of others

after its execution.

- L. After installation, submit photographs showing cable entries and terminations within equipment racks, enclosures, and pedestals at the job site.

1.6 CONTRACTOR QUALIFICATIONS

- A. The Contractor or sub-Contractor if so, executed shall currently maintain a locally run business within a 100-mile radius for a minimum of five years, and shall be an authorized distributor and service center for the supplied equipment having full warranty privileges.
- B. The Contractor or sub-Contractor if so, executed shall maintain at his facility the necessary spare parts in the proper proportions as recommended by the equipment manufacturer to maintain and service the equipment being supplied. These facilities and inventory shall be made available for inspection by the Engineer.
- C. At the time of bid submission, the Contractor or sub-Contractor if so executed shall have manufacturer specific certifications, with regard to programming, installation, troubleshooting and servicing, for the system components being provided, in particular certifications for the Digital Signal Processors, Digital Mixing Consoles and Amplifiers, as well as an Infocomm Certified Technology Specialist – Installer (CTS-I) who shall act as the on-site foreman, and an Infocomm Certified Technology Specialist – Designer (CTS-D) who shall act as on staff engineering support. Furthermore, all Dante programming and configuration shall be performed by an Audinate Level 2 Certified technician.
- D. The Contractor or sub-Contractor if so, executed shall have a minimum of five installations of like magnitude and complexity within the last three years.

1.7 SUBMITTAL REQUIREMENTS

- A. Contractor shall be required to provide submittals and shop drawings to Owner within twenty (20) calendar days of date of award notice, acknowledged with a binding letter of intent. Contractor shall be responsible to ensure that the dimensions and specifications of each component and all systems fit within the building allowances. The Owner, Architect and Engineer must review and approve all submittal documents prior to the start of work. Contractor shall advise the Owner of any discrepancy that could affect installation. If Contractor fails to notify Owner of any discrepancies, Contractor shall assume responsibility for providing the required equipment or correcting such discrepancies at no additional cost to Owner.
- B. Submittals that are incomplete, deviate significantly from the requirements of the Contract Documents, or contain numerous errors will be returned without review for rework and re-submittal, and may result in back charges to the contractor
- C. Approval of submitted items indicates only the acceptance of the manufacturer and quality. Specific requirements, arrangements, and quantities shall comply with the intent of the Contract Documents as interpreted by the Owner unless specifically approved in writing
- D. Submittals shall be provided digitally in PDF electronic file format and include Contractor's approval.

1.8 ACTION SUBMITTALS

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

1. Provide a complete LIST of proposed equipment with reference to its corresponding specification paragraph number or equipment title in specification paragraph order. Where multiple devices can utilize the same product data sheet, provide individual submissions for each device specifically hi-lighting or otherwise making the specific selection obvious to the reviewer that information which specifically applies to the device for which the submission is being provided.
 2. Provide preparation instructions and recommendations.
 3. Provide storage and handling requirements and recommendations.
 4. Provide installation methods.
- B. Shop Drawings: For all speakers, speaker clusters, equipment racks and related equipment.
1. Include plans, elevations, sections, and attachment details.
 2. Include detail drawings of all custom fabricated items and approved equipment modifications.
 3. Include complete parts lists, schematic diagrams, and all dimensions required for proper assembly.
 4. Include component weight and power calculations.
 5. Include point-to-point wiring diagrams from initial signal source to final signal destination and typed wire schedule identifying every connection and cable utilizing an Owner approved cable identification scheme. Include in schedule cable type and gauge. Include all intermediate electronic devices such as all electronic components, transceivers, switches, transformers and terminal blocks. Indicate locations of all components. Identify cables by type, color, and cable identification.
 6. Submit conduit riser diagrams showing required conduits and junction boxes along with fill including types and quantities of cables to be contained in each conduit. Where existing pathways are utilized indicate such re-utilization and restate the specifics of that pathway as to size, etc. as well as any current contents of pathway. Show details of weatherproofing, lightning protection and grounding, strain relief and cable support, fire stop protection, and wall penetrations through all rated partitions.
 7. Submit rack layouts indicating the proposed arrangement of mounted equipment including power junction box location. Rack layouts shall be dimensionally accurate and include front and rear views.

1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Manufacturer and Installer
1. Submit a list of all lower tier subcontractors and suppliers. List shall include lower tier subcontractor's qualifications indicating performance of similar work on past projects of this type and scope, as well as indicating any special certifications associated with said work; e.g. submit a copy of the certification(s) held by the party responsible for the termination and testing of the fiber optic system. The Owner reserves the right to reject any subcontractors without reservation or cause and shall have the final authority on such rejections.
- B. Product Test Reports: For each type of equipment, for tests performed by a qualified testing agency.
- C. Product Certificates: For each type of equipment.
- D. Project Schedule: Outlining equipment delivery dates and installation start and finish dates. Project schedule shall be broken down into sufficient detail (work task and duration) to permit Owner to monitor installation progress on a daily basis. Include required approval dates by Owner/Architect.

- E. Field quality-control reports.
- F. Sample Warranty: For all manufacturer's special warranties and system warranties
- G. Copies of all required business and contractor licenses.
- H. Proof of Insurance

1.10 CLOSEOUT SUBMITTALS

- A. In addition to any close-out requirements that may defined elsewhere in these Documents, when the installation is substantially complete including the Testing Reports in Part 3 of this Section, Contractor shall submit two (2) complete initial hard copy sets of the closeout submittals as listed below to the Owner and Engineer for review and approval. After review and approval of initial set, Owner shall return one (1) initial hard copy to Contractor with comments for updating. Contractor shall provide four (4) final sets of closeout submittals to Owner and one (1) electronic copy in PDF format. Closeout submittals shall include, but not be limited to:
 - 1. Project Record Drawings (As-Built Drawings) including, but not limited to:
 - a. electrical drawings,
 - b. device and equipment schedules,
 - c. system block diagrams,
 - d. system wiring diagrams,
 - e. rack layout drawings,
 - f. custom fabricated signage drawings (final fabrication version)
 - g. testing and commissioning data formalized into a report format
 - 2. An Operation and Maintenance Manual.
 - 3. Full documentation of all programming provided, including, but not limited to, initial configurations settings and system presets or other operational settings in a robustly commented pre-compiled format, or for those pieces of equipment programmed through a graphical programming interface full graphic configuration with a types listing of any calibrations or settings input for any graphic element not explicitly listed in the graphic.
 - 4. Provide two (2) copies of electronic backups of all programming and configuration executed.
 - 5. A schedule of all equipment provided and its location within the facility. List shall include manufacturer name, model identifier, serial number, firmware versions and any other pertinent information needed to obtain service, maintenance, and/or replacement.
 - a. For all devices and equipment utilizing an Ethernet based transport, include the MAC addresses.
 - b. For all devices and equipment that utilize TCP/IP routing protocol, include the internet protocol addresses.
 - c. For all devices and equipment that utilize any other addressable protocol(s), include the names, addresses and/or any other unique information utilized to track and/or communicate with the devices or equipment.
 - 6. Provide a list of ALL passwords for programming, administration and control features and functions for all hardware and software. Submission of the form to be included shall be sufficient for the engineering review copy of this document, as it will only be necessary to provide the passwords to the Owner.
 - 7. Provide three (3) sets of all keys for each locked piece of equipment.
 - 8. A list of all Subcontractors who performed work for Contractor during installation. List shall include company name, physical company address, phone number, and contact person(s), as well as the scope of work provided by the subcontractor.
 - 9. Documentation certifying old equipment and associated support structures that were demolished by Contractor prior to the installation of new equipment have been properly

- disposed or recycled per local, provincial, and/or federal law(s).
10. Test reports from an independent testing & inspection agency certifying that bolted and/or welded connections for primary and/or secondary structural steel meet the minimum requirements of the engineered structural drawings, the governing building code, or as required by the building official; whichever is more restrictive.
 11. All testing and commissioning reports as specified in Part 3 below.
 12. Warranty Documentation, including, but not limited to, specific warranty verbiage from the various manufacturer, durations for each device covered, as well as start date(s), and copies of any/all documents submitted to the manufacturer on behalf of warranty commencement.

1.11 OPERATION AND MAINTENANCE MANUAL

- A. Upon substantial completion and prior to onsite training with the Owner, Contractor shall provide four (4) final hard copies and one electronic copy Operation and Maintenance Manuals (O&M Manuals).
- B. Electronic files shall be in .pdf format, except for drawings which shall be in .DWG format, and programming files which shall be in the native format of the programming software within which it was created pre-compiled a heavily commented.
- C. O&M Manuals shall have tab dividers and shall be logically organized to provide easy access to information without the need to research through entire manual.
- D. All documents provided in the O&M Manual shall be written in English and shall provide sufficient detail as to be understood by an individual with no knowledge of LED displays or the associated control equipment and/or operating systems.
- E. Contents of the O&M Manual shall include, but not be limited to:
 1. Table of Contents
 2. Description of system(s) including key features and operational procedures.
 3. Full start up procedure for all equipment written under the assumption that all equipment was in full powered off mode.
 4. Full shutdown procedure for all equipment written under the assumption that the facility is in fully powered up use
 5. Troubleshooting procedures for DSP's, amplifiers, Dante network devices and equipment, and all related equipment provided by Contractor. Troubleshooting procedures shall include demonstration photos and/or diagrams as required.
 6. Maintenance procedures for DSP's, amplifiers, Dante network devices and equipment, and all related equipment provided by Contractor. Maintenance procedures shall include demonstration photos and/or diagrams as required. Contractor shall indicate whether maintenance procedures should be performed monthly, bi-annually, or annually.
 7. Owner's Manuals for all third party and/or "off the shelf" type equipment provided by Contractor, e.g., KVM's, fiber modems, network switches/routers, and UPS battery back ups
 8. All third-party equipment and/or "off the shelf" equipment warranties and a notarized System Warranty.
 9. Instructions for alternative control operations for intramural or other non-game day use by untrained university staff.
 10. Hard copy listings and electronic copies transferred to a USB connected mass storage device of all programming code and configuration software data files in a pre-compiled format capable of being opened and modified in the standard software utilized to do the initial programming.

1.12 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products in strict compliance with the manufacturer's instructions and recommendations, as well as industry standards.
- B. Store products in manufacturer's unopened packaging until ready for installation
- C. Store materials within absolute limits for temperature and humidity recommended by manufacturer. Protect from damage.

1.13 SEQUENCING

- A. Ensure that information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress. Coordinate with the General Contractor for the associated infrastructure bid package to assure effective and complete installation of work.

1.14 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results.
- B. Verify field measurements prior to commencement of work.
- C. Do not install products under environmental conditions outside manufacturer's absolute limits.
- D. Do not install suspended products and/or products located on the catwalk until contractor responsible for any/all structural modifications has completed work impacted by such additions of weight and/or structural stresses.
- E. Products shall not be installed until painting and other finish work is complete.

1.15 WARRANTY AND SERVICE

- A. Contractor shall warrant all labor and materials for twenty-four (24) months following the date of Final Acceptance.
- B. During the warranty period the system shall be free of defects and deficiencies and conform to the drawings and specifications with respect to the quality, function, and characteristics stated.
- C. Contractor shall repair or replace all defects that occur in labor or materials within the warranty period. On-site labor shall be included during the warranty period. Any/all warranty replacements and repairs shall not lessen or terminate subsequent warranty for all material and labor for the entirety of the system including those materials either repaired or replaced.
- D. Failed parts whose replacement is performed without onsite intervention by the Contractor shall be returned to the Contractor for repair at a service facility located in the United States. Contractor shall identify the location of its service facility in the documentation provided when submitting a bid for this work.
- E. The Contractor shall replace failed parts that cannot be repaired.

- F. Upon receipt of a failed part, Contractor shall return a repaired or replacement part to the Owner within fifteen (15) business days from receipt of failed part. Replacement parts shall be new, or like new and operational as if new.
- G. The Contractor shall be responsible for providing the following emergency response availability:
 - 1. Telephone service assistance and technical support for problem diagnostics and programming/operational issue resolution.
 - 2. A parts exchange program, including advance parts replacement via same day shipment. The manufacturer shall keep a ready stock of key assemblies available to ship out upon notice of a parts failure if part is not available in spare parts inventory at Owner's facility.
 - 3. During the warranty period all devices and equipment necessary for the ongoing operation of the scoreboard shall be available to be provided as an advanced replacement. The advance replacement should contain all of the shipping information and packaging necessary to return the defective part or assembly back to Contractor at no cost to the Owner
- H. The Contractor shall supply at least one local service employee or local authorized service agent for servicing and repair of all equipment during the warranty period. Local service employee or local authorized service agent shall be located within 200 miles of Owner's facility.
- I. The local service employee or local authorized service agent shall, when required, provide on-site support within 24 hours of notification.
- J. The local service employee or local authorized service agent shall maintain at their office/service depot a stock of the most common components that may require replacement. The stock shall be maintained and shall be eligible as previously define in this Section as advance replacement stock. And, when necessary, shall act as same with the manufacturer replenishing their local service stock instead or requiring a second site visit and system replacement.
- K. Warranty shall cover all equipment, including processors, controllers, operating systems, and software.
- L. Warranty shall include two annual on-site system check-ups by a qualified technician who is a full-time employee of the Contractor. Visit to occur approximately 2-3 weeks prior to the start of the second and third seasons or as determined by Owner.
- M. Check-up shall include all regular maintenance; including filter changes, a complete inspection of all systems, system performance level based on original calibrations, parts replacement where required and a complete written report of all findings.
- N. Following the warranty period, a separate service agreement will be pursued at the owner's discretion.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

- A. As indicated elsewhere in These Documents, the products specified on these Construction Documents are to be furnished as indicated. Any deviation from the use of materials or products shall be handled in accordance with terms and conditions established elsewhere in These Documents. Where substitutions are not previously approved in writing by the Engineer, they shall be deemed unacceptable.

2.2 PRODUCTS

A. All products shall be new, UL listed and comply with all applicable Federal, State and Local regulations. B Stock items are not allowed.

B. Audio

1. Microphones

a. Wireless

1) Performance Metrics:

- (a) Dynamic Range: >115 dB A weighted, typical
 - (b) Output: XLR Balanced +14 dBV minimum
 - (c) THD: <1.0%, 1kHz, ± 17.5 kHz
 - (d) Modulation: FM
 - (e) Operating Sensitivity: 20dBuV @ 60dBA SNR
 - (f) Channel Config:
 - (1) 40 Channels/band minimum, Frequency Agile
 - (2) 25 kHz Channels
 - (g) Spectrum: UHF, coordinate availability in band with local licensing and conditions
 - (h) Operating Range: 100m, open field
- ##### 2) Manufacturers and Series
- (a) Audio Technica 3000 Series,
 - (b) Equivalent product by: Shure, Sennheiser
- ##### 3) Receivers:
- (a) ATW-3211 Series (470-530 MHz) – Provide 2
- ##### 4) Handheld
- (a) ATW-T3212 Series (470-530 MHz) – Provide 1
 - (b) ATW-C510 Cardioid Dynamic Microphone Capsules – Provide 1
- ##### 5) Lavalier
- (a) ATW-T3201 Body-Pack Transmitter – Provide 1
 - (b) AT831cH Lavalier Microphone – Provide 1
- ##### 6) Charging System
- (a) As manufactured by the manufacturer of the microphone system. Provide either individual chargers or multiple charger units for 100% of the battery powered devices being provided.
- ##### 7) Antenna System
- (a) Remote antennas to within the room serviced
 - (b) Provide cabling as needed to remote antennas to desired locations

b. Microphone Stands

1) Floor Stand

- (a) Adjustable 36" – 60" chrome stand with 10" diameter round base, rubber feet, and minimum 9 pound weight – Provide 1

2) Manufacturers

- (a) Atlas Soundolier
- (b) Proline
- (c) Shure

2. Audio Player

a. Disk Formats and File Systems:

- 1) Disk: CD-DA, CD-ROM, CD-R,
- 2) USB: FAT16 and FAT32

b. File Formats: .cda, .wav, .mp3

c. SNR: >90 dB (A-weighted)

- d. Frequency Response: 10Hz – 20kHz
 - e. THD: 0.01%
 - f. Dynamic Range: > 85dB
 - g. Channel Separation: >80dB
 - h. Outputs:
 - 1) Unbalanced: RCA, >10k Ω , 2 Vrms @ 10k Ω
 - 2) Balanced: XLR, >10k Ω , +4dBu
 - i. Remote Control: IR, RS-232C, IP
 - j. Bluetooth:
 - 1) Version 4.0
 - 2) Codecs: SBC, MP3
 - 3) Range: 82 ft.
 - k. File Folder Limits:
 - 1) Storage Capacity: $\leq$ 2TB
 - 2) File Size: $\leq$ 2GB
 - 3) File Name Length: $\leq$ 255 Characters
 - 4) Number of Files: $\leq$ 999/Folder
 - 5) Number of Folders: $\leq$ 999
 - 6) Number of Folder Levels: $\leq$ 8
 - l. Manufacturer and Model:
 - 1) Denon-700CB, equal by Tascam or Yamaha.
3. Digital Signal Processor
- a. Fixed preconfigured I/O configuration
 - b. Input: 12 mic/line (minimum)
 - c. Output: 8 mic/line (minimum)
 - d. GPIO: 4 chan (minimum)
 - e. Frequency Response; 20 Hz to 20 kHz, +4 dBu output: +0.25 dB/-0.5 dB
 - f. THD+N (22 Hz to 22 kHz)
 - 1) 0dB Gain, +4 dBu input: <0.006%
 - 2) 54 dB gain, -50 dBu input: <0.040%
 - g. Dynamic Range; 22 Hz to 22kHz, 0 dB gain: >108 dB
 - h. Input Impedance (Bal): 8k Ω
 - i. Output Impedance (Bal): 207 Ω
 - j. Max input: +24 dBu
 - k. Max Output: =24 dBu, +18 dBu, +12 dBu, +6 dBu, 0 dBu, -31 dBu selectable
 - l. Input Gain Range: 0-66dB (6 dB steps)
 - m. Sampling Rate : 48 kHz
 - n. Processor programming configurable through GUI programming interface
 - o. Network Connectivity: Gigabit Ethernet
 - p. Remote control: Ethernet
 - q. Basis of Design:
 - 1) Biamp Forte AI
 - 2) Equivalent Product by: QSC or BSS
4. Amplifiers
- a. Configuration: 2 Ch
 - b. Sensitivity: 1.4V
 - c. Power Output: 300W/Ch min
 - d. Input Impedance : >20k Ω
 - e. Output : 70V
 - f. Frequency Response : 20 Hz – 20 kHz
 - g. THD <0.5% @ 1kHz
 - h. SNR 100 dB, 20 Hz – 20kHz

- i. Processing : Integrated DSP
 - j. Manufacturer
 - 1) Crown, LEA, QSC
 - 5. Speakers:
 - a. Configuration: Two way 6.5" LF Driver, .75" HF Driver
 - b. Nominal Dispersion Pattern: 120° Conical
 - c. Frequency Range: 70 Hz – 13.5 kHz
 - d. Power Handling: 60W continuous @ 8Ω
 - e. Transformer: 70V/100V 30W, 15W, 7.5W, 3.75W
 - f. Output: 109 dB continuous, 115 dB Peak
 - g. Sensitivity: 91dB 1W/1M
 - h. Mount: ceiling recessed
 - i. Finish: White from factory, coordinate with architect and paint to match as may be necessary
 - j. Manufacturer and Model
 - 1) Community C6, equal by JBL, QSC
 - 6. Hearing Assistance System
 - a. Frequency Response: 50 Hz – 15 kHz
 - b. SNR: 50 dB minimum
 - c. Input: XLR-F, balanced, -55 dBu mic level, 20kΩ impedance
 - d. THD: <2%
 - e. Technology: RF
 - f. Spectrum: VHF
 - g. Transmitter Output Power: 100 mW
 - h. Range: 3000 ft., open field
 - i. Components:
 - 1) Transmitter: Stationary: Provide 1
 - 2) Rack Mount Kit: Provide 1
 - 3) Antenna Kit: Provide 1
 - 4) Assistive Listening Notifications Signage Kit: Provide 1
 - 5) No receivers, ear buds or induction loops required, as this system will use those provided under the scope of the Stadium System
 - j. Manufacturers
 - 1) System shall match and be compatible with that which is being provided for the stadium.
- C. Video
- 1. Displays
 - a. Type "BB"
 - 1) Display Size: 70"
 - 2) Resolution: 3840 x 2160
 - 3) Display technology: Edge LED
 - 4) Brightness: 700 nit Min
 - 5) Contrast: 4000:1
 - 6) Viewing Angle: 178° x 178°
 - 7) Response Time: 8 mS or better
 - 8) Input: HDMI 2.0 with HDCP 2.2 compliance
 - 9) Control: RJ45 Ethernet via TCP/IP
 - 10) Rated Operation Time: 24 x 7
 - 11) Manufacturer: Samsung, LG, NEC
 - 12) Provide mounting brackets as manufactured by Chief, Peerless or Premier as recommended by manufacturer for specific display provided.
 - b. Type "TM"

- 1) Same as “SD”
 - 2) Provide mounting bracket to allow for Landscape mounting of monitor.
 2. Projector
 - a. Light Engine Technology: DLP Laser
 - b. Brightness (Color and White): 10,000 ANSI Lumens min
 - c. Native Resolution: UHD (3840 x 2160)
 - d. Contrast Ratio: 100,000:1
 - e. Aspect Ratio: 16 x 9
 - f. Lens: As required by throw
 - g. I/O:
 - 1) Video: HDMI x2, HD-BaseT, Display Port
 - 2) Control: RS-232, Ethernet/IP
 - 3) Audio: Stereo Out
 - h. Manufacturer:
 - 1) Vivitek, Digital Projection, Epson, Barco
 3. Distribution Amplifier
 - a. Support Computer and video resolutions up to 4k/60 @ 4:4:4
 - b. Support HDMI 2.0b, including data rates to 18 Gbps, HDR, Deep Color up to 120bit, 3D, and HD lossless audio formats
 - c. HDCP 2.3 compliant
 - d. Provide auto input cable equalization
 - e. Provide automatic EDID managed communications between devices
 - f. Provide RS-232 control
 - g. Provide Rack mounting hardware
 - h. Manufacturer and model: Extron DA4 HD 4K PLUS 60-1608-01
- D. Control System
 1. Control Processor
 - a. SDRAM shall be a minimum of 512 MB.
 - b. Flash shall be a minimum of 4GB.
 - c. Communications shall be by means of standard Ethernet 10/100/1000 using TCP/IP.
 - d. Control Processor shall be rack mountable with all necessary mounting hardware.
 - e. Control I/O connections shall be a minimum of:
 - 1) 3 bi-directional RS-232
 - 2) 8 IR/Serial
 - 3) 8 digital
 - 4) 8 relay
 - 5) 1 10/100/1000Base Ethernet
 - f. Manufacturer and Model shall be:
 - 1) Crestron CP3N, equal by Extron or AMX
 2. Control Panel
 - a. Display shall be TFT active matrix LCD
 - b. Minimum 7” diagonal screen.
 - c. Minimum 350 nit brightness.
 - d. Minimum 5 programmable hard keys on face.
 - e. Communicate by means of Ethernet.
 - f. Powered by means of 802.3at Power over Ethernet.
 - g. Single source manufacturer with the control processor
 - h. Manufacturer and Model shall be:
 - 1) Crestron TSW-760, verify color with architect prior to procurement
- E. Connectivity
 1. Cabling
 - a. Microphone

- 1) All microphone cable shall be UL rated.
- 2) All microphone cable shall be 22 AWG stranded copper wire.
- 3) All microphone cable shall be low capacitance.
- 4) All microphone cable shall have a continuous foil shield with drain conductor.
- 5) Acceptable Manufacturer and Model shall be:
 - (a) West Penn D25291 plenum and 77291 for non-plenum
 - (b) Or equivalent product by Liberty Wire and Cable or Belden
- b. Speaker
 - 1) Front of House Program Speakers: 12 AWG stranded copper wire.
 - 2) Program Monitors and Ceiling Speakers: 18 AWG stranded copper wire.
 - 3) Acceptable Manufacturers
 - (a) West Penn:
 - (1) 12 AWG 25227 plenum
 - (2) 18 AWG 25224 plenum
 - (b) Or equivalent product by Liberty Wire and Cable or Belden
- c. Patch Cords:
 - 1) Provide all indicated or as may be required for complete connection of all system components
 - 2) All terminations shall be tinned with solder prior to termination, and solder to their connector where the means of connection can withstand such process.
 - 3) All patch cords for network connections shall comply with Section 27 15 13 Communications Copper Horizontal Cabling, and shall match the manufacturer provided under the structured cabling scope of work.
 - 4) All audio patch cords shall match the gauge of the cabling being provided for the balance of the cabling run, and shall be terminated with a mechanical means assuring disconnection and reconnection consistency.
2. AV Extenders
 - a. Wired Extender Pairs
 - 1) Matching pair provided by a single manufacturer, and designed for interoperability with each other, provisioning like performance metrics
 - 2) Rated for the full EIA/TIA category rated distance of the network cables being 100m.
 - 3) HDCP 2.3 compliant.
 - 4) Compatible with standard Category 6 rated UTP.
 - 5) Acceptable Manufacturer and Model shall be:
 - (a) Extron DTP HDMI 4K 230 Tx//Rx, equal by Crestron or Atlona
 - b. Wireless Extender
 - 1) Compatible with Windows, MAC, iOS and Android
 - 2) Wireless Point to Point connection.
 - 3) Capable of receiving video with a minimum of 1080p/60 with stereo audio.
 - 4) Provides a canvass capable of concurrently up to 4 simultaneous video inputs.
 - 5) Compliant with HDCP 2.3.
 - 6) Acceptable Manufacturer and Model:
 - (a) Barco Clickshare CX-20, Extron eLink 100, Crestron AM-200
3. Receptacle Stations and Related Hardware
 - a. Standard Faceplates: Brushed Aluminum, as manufactured by ProCo, Panelcrafters/Liberty A/V or Switchcraft.
4. Bluetooth Receiver: As provided by the audio player, remote receiver to provide full coverage of area being serviced
5. Transformer: For transforming constant voltage paging from the local zone to line level for input into the audio system.
 - a. Radio Design Labs, TX-70A

F. Hardware

1. Equipment Cabinet
 - a. Black electrostatic finish
 - b. EIA 19" Rack mount front and rear rails, 10x32 drilled and tapped with visible RU indicator
 - c. 16 Rack Units high
 - d. Three section
 - e. 22.3" Deep
 - f. Front and Rear locking
 - g. UL Listed 1678
 - h. 14 gauge frame, 16 gauge side frame, 14 gauge top and bottom sections
 - i. Provide 3U drawer with customizable foam insert.
 - j. Provide lacing brackets at both back corners
 - k. Middle Atlantic DWR-16-22
2. Power Distribution Unit
 - a. PDU shall be horizontal, rack mount, 15A 120V
 - b. PDU shall provide three duplex receptacles that shall power up and down per safe sequence to protect the equipment in the cabinet, plus one duplex that is non-switched.
 - c. PDU shall have all connections rear mounted.
 - d. PDU shall be controllable by a minimum of a discrete closure from the control system, RS-232 control acceptable.
 - e. Provide 1 per cabinet
 - f. Acceptable manufacturer and model:
 - 1) Furman M8-S
3. Grounding
 - a. 19" x ½" horizontal ground bar as provided the cabinet manufacturer.

G. Misc Hardware

1. Provide any/all hardware and accessories required to complete the design intent provide, as well as may be required to comply with any/all applicable codes, audiovisual industry standards and best practices, and to assure a safe operational environment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall neatly label and dress all cabling to assure easy maintenance and troubleshooting. Within all equipment enclosures, including but not limited to, video equipment racks, the Contractor shall utilize Velcro straps or Milli-Tie wraps for bundling of signal wires. Within all enclosures provide and utilize lacing bars and surfaces to assure neat and trouble-free system operation and maintenance.
- B. All cabling labeling shall be by means machine generated labels that wrap the complete cable diameter. Adhere labels within 6" of each end of the cable ends. Label all speaker cabling at the rack end with the specific speaker ID. Label all speakers at the speaker end with both the speaker ID and the amplifier ID.
- C. Label all components with the device name derived under Paragraph 3.2 below. Labels shall be machine generated on a self-adhesive tape or phenolic engraved tag.
- D. Rack and stack all cabinets, and/or clusters of equipment in the Contractor's shop in a controlled environment. Verify that the completed cabinets, and/or equipment cluster operates properly prior to

transporting the cabinets and/or equipment clusters to the job site for final assembly.

- E. After assembly of the system on site, execute all required programming, calibration, and commissioning to optimize performance of the system within the constraints of the installed environment.
- F. Mount all speakers and other components as either specified or drawn, or for cases where explicit instructions are not given within these Documents, execute all installation to the highest level of industry best practices. After installation of these speakers and other devices are completed, verify all mechanical and electrical connections are executed per recommended by the device manufacturer, and all items are safe and secure.
- G. Fully test the system for component operation, as well as project specific programming. Document the testing procedures and the results of the testing. Submit hard copy of the testing documentation in the Operations and Maintenance Manuals submitted at time of close out.
- H. Equipment Racks
 - 1. The Contractor shall submit to the Engineer for approval, the intended cabinet layouts, prior to installation. Upon written approval of the cabinet layouts the Contractor may proceed with this installation.
 - 2. Cabling shall be routed, combed, and bound neatly as it is routed in the cabinet. Orderly cable bundles shall be grouped and secured to the cabinet structure. Cables shall be provided with enough service loop to enable the contractor to route all cabling up the sides of the cabinet to the height of the device to be connected, and then over to that device.
 - 3. Failure to comply with this requirement shall give the Owner or Engineer the option to require the Contractor re-dress the cabling or remove it in whole and re-install the cabling.

3.2 PROGRAMMING and CONFIGURATION

- A. Unless otherwise directed by the District IT staff, all network devices shall be assigned permanent IP addresses. These addresses shall be coordinated with Owner's IT personnel. The Contractor shall then program all devices with these IP addresses and inventory. Document all MAC addresses, manufacturers, model numbers and serial numbers. Include all assigned IP addresses in the aforementioned documentation. Include both hard and electronic copies in the Operations and Maintenance Manuals submitted at time of close out.
- B. All devices having the ability to program names shall be programmed with meaningful names. Coordinate the naming convention with the Owner prior to programming. Include a schedule of the devices and the corresponding names in the Operations and Maintenance Manuals submitted at the time of close out.
- C. Program the mixer channels with user friendly names consistent with the naming convention previously mentioned. Program the DSP utilizing the same user-friendly names.
- D. Program the internal DSPs of each amplifier with the proper characteristic parameters unique to the speakers being installed.
- E. Equalize and tune the system to provide optimum performance of all components and the complete system. Equalize and time alignment all speakers. Equalization and time alignment shall be programmed within the system DSP, not the mixers or the amplifier's processing.

- F. Calibrate the signal chain's gain structure to maximize the dynamic range of the system. Adjust the gain structure to a threshold just below clipping and to provide a minimum of 14dB of headroom.
- G. Program the systems for:
 - 1. System On/System Off both users driven, and time scheduled as previously stated.
 - 2. Source-select for individual volume control, including, but not limited to, each video display
 - 3. Master Volume control
- H. While both project specific and general best practice procedures for programming and operations have been explicitly indicated herein, provide all required programming and configuration to fully realize the intent of the design.

3.3 LABELING

- A. All wires and cables shall be labeled with either a self-laminating label designed for labeling wire and cable, or by wrapping a pre-printer or computer-generated label designed by the manufacturer for this purpose, and by sealing it with clear heat shrink tubing over the entire label.
- B. Failure to comply with this requirement shall give the Owner or Engineer the option to require the Contractor re-dress and re-label the cabling or remove it in whole and re-install and re-label the cabling.

3.4 GROUNDING

- A. This rack shall be bonded back to the nearest available TELECOMMUNICATIONS BUSBAR with a minimum #6 AWG bonding conductor, utilizing a two-hole irreversible lug at both ends of the conductor. Each cabinet or rack shall have an individual homerun bonding conductor. Daisy chaining of the bonding conductor is unacceptable.

3.5 CALIBRATION AND COMMISSIONING

- A. System Commissioning, including testing and certification of system performance, shall be completed by a factory certified/authorized representative prior to final payment. Said representative shall be fully certified by the manufacturer, and not simply an employee of the Contractor relying upon the Contractor's company certifications. All system operation or installation deficiencies and resultant corrective actions shall be documented and submitted to the Owner at time of commissioning and shall be resolved prior to final training and final payment. Final payment shall be held until such time that final commissioning and training is completed to the satisfaction of the Owner and Engineer.
- B. All installation and calibration of equipment shall be by qualified and certified personnel. All calibrations shall be checked by appropriate calibration equipment. Calibrations made simply by authoritative and/or experienced eyes and/or ears are not acceptable.
- C. Test all cables prior to termination. Cabling having industry recognized standardized testing procedures, above basic continuity and other simple testing, shall be tested utilizing test devices designed for said tests.
- D. All test and measurement devices and equipment that are designed to be calibrated, shall be calibrated by a NIST certified process/test facility no more than one year time prior to use. This threshold shall be shorter where recommendations either by the device/equipment manufacturer or industry best practices recommend more frequent calibration for optimum results.
- E. Turn on, and individually test all components to assure the individual component or device is operating within normal operational parameters, prior to assembling them into the larger system.

- F. Document all calibrations and adjustments in machine generated print in a neat and organized fashion for transmission to the Owner. Include any/all test and measurement device and equipment reports in human readable format. The Engineer reserves the right to review, reject or require modification or further documentation prior to completion of the project.
- G. Unless otherwise recommended by industry acknowledged best practices or standards for this application, calibrate the system to provide a unity gain structure through the signal path. Where said best practices or standards would indicate other than this gain structure, provide documented procedures and expected results as to the alternative method to the Engineer for review and approval prior to execution. Do not proceed with these alternative calibrations without the prior written approval of the Engineer.
- H. The Engineer shall be given the opportunity to monitor, and as may be needed participate in, the calibrations and commissioning. The Contractor shall apprise the Engineer two weeks prior to commencement of said calibrations and commissioning to facilitate effective scheduling of the Engineer's time to attend same. Should such courtesies not be extended to the Engineer prior to the final calibrations and commissioning, the Engineer reserves the right for the procedures to be completely repeated prior to considering job completion.

3.6 WORK COMPLETION

- A. The Contractor shall provide a complete and functioning system, based on the intent of the designs as set forth in these Documents. Any/all equipment, either implied or intentionally omitted from these documents, but generally accepted as being required for the completion of the installation, as represented in these Documents, shall be provided by the Contractor at no additional cost to the Owner.
- B. The Contractor shall provide a copy of all test results, programming, or other documentation to the Engineer for review and approval prior to Owner acceptance.
- C. The Contractor shall provide all recommended fixed and flexible wire management to achieve a high-quality installation both visually and operationally, and that would be considered within the standard practices of good workmanship. The Contractor shall speed wrap all loose cables routed between end devices and their associated destination such as between a projector and the associated faceplate, or between the cabinets and enclosures, and the associated faceplate and ancillary devices.
- D. Demonstrate the fully functional system to the Engineer and Owner prior to training or job completion to assure compliance with the design intent.
- E. Complete ALL punch list items provided by the Engineer prior to submission for substantial completion.
- F. Create electronic backup files of configurations and other programming for each of the preset operations. Record same onto electronic storage media. Make 3 copies of same. Provide these copies to the Owner at the point of system acceptance. Should system acceptance extend past the expected point of facility substantial completion, provide interim copies for the Owner prior to first use of the systems(s).
- G. Complete training as prescribed elsewhere in these Documents.
- H. Submit close out documentation for review and approval by the Engineer prior to Substantial Completion or processing of O&M manuals through the construction process to the Owner. Correct any/all issues cited by the Engineer prior to submission to the CM for release to the Owner.

3.7 TRAINING

- A. The Contractor shall perform formal training with permanent staff personnel under the employ of the Owner. Such training shall last a minimum of 2 hours.
- B. At the time of training, the Contractor shall obtain a sign in sheet that shall be copied with one copy being kept on file by the Contractor, and one copy being forwarded to the Owner. The sign in sheet shall at a minimum contain the following information:
 - 1. Date
 - 2. Time
 - 3. Location of training
 - 4. Name of system on which trained
 - 5. Name, organization, department, role, E-Mail address and phone number of each participant.
 - 6. The signature of the trainer
 - 7. A copy of the approved itinerary
- C. The training shall be video captured in a minimum of 1080p resolution in a standard digital format capable of viewing on a standard computer running current releases of Windows, Mac or Linux. The subsequent video shall be recorded on to a USB connected storage device. The Contractor shall provide four copies of the USB connected storage device, one for each copy of the Operations and Maintenance manuals.
- D. All costs associated with these training requirements, including, but not limited to the supplemental trainings and their associated travel, shall be included in the base bid costs of the Contractor, and shall garner no additional reimbursements or funds.

3.8 WARRANTY

- A. Warranty of the system, including parts and labor, shall be by the system supplier and manufacturer for all materials and workmanship for a period of no less than two (2) years, or for the duration of the manufacturer's documented warranty whichever is greater. Should for some unforeseeable reason, the installer not be able to complete the term of the warranty, the manufacturer shall bear the complete responsibility of the warranty for both parts and labor and shall appoint a certified service organization to complete the term of the warranty. The manufacturer shall inform the Owner of this appoint in writing. The Contractor shall present assurance of this stipulation from the Manufacturer to the Owner in writing prior to commencement of work. Should the Contractor not provide this written assurance, the Owner shall retain the right, as outlined elsewhere in these Documents, to obtain satisfaction, including but not limited to, financial restitution to the Owner.

END OF SECTION 27 41 17.2

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SECTION 27 41 17.3 – VOCAL AND MUSIC ROOM AUDIO VISUAL SYSTEMS

PART 1 - GENERAL

1.1. WORK INCLUDES

- A. Work in this section includes, but is not limited to, furnishing, and installing a fully integrated Audio system as indicated on the Drawings in all Vocal and Instrumental Music Rooms. Provide one complete system per each Vocal and instrumental Music Room.
- B. This Section and the associated Drawings and Diagrams convey the intent of the design. The system(s) shall be provided in its entirety to provide a complete and working system(s) as expressed by this intent. Items drawn but not specified or specified but not drawn shall be provided as if included in both. Furthermore, it is incumbent on the Contractor to provide any device(s) required to make the system(s) fully functional to the intent of the design, whether indicated or not.
- C. Products Supplied but not installed by the Contractor
 - 1. The Contractor shall coordinate the delivery of items that must be installed by other trades to assure timely delivery.
 - 2. The Contractor shall verify lead times of all items required under this heading. Should the delivery of such items be delayed due to the Contractor's efforts, or lack thereof, the Contractor shall bear the burden of compensation to all related trades and for any expedited handling, so as to regain any loss incurred by the project schedule.
- D. Products Installed but not Supplied by the Contractor
 - 1. It shall be incumbent upon the Contractor to verify the exact requirements of any system, device, equipment, or Materials supplied to them for installation by others. Any deviations between the Contract Documents and these requirements shall be brought to the immediate attention of the Engineer, and to the other trades as necessary.
- E. Devices, equipment, or other infrastructure installed by other contractors in support of this Contractors efforts
 - 1. It shall be the responsibility of this Contractor to coordinate with the other contractors on the project who shall be providing items such as rough-in box and conduit to facilitate this Contractor's systems and device to verify the appropriateness and location of these items.
 - 2. This Contractor shall provide any necessary guidance as to the correctness of the information being used by these other contractors. Any item(s) either being provided out of Specification, in the wrong location, or inappropriate for the application shall be:
 - a. intervened upon immediately,
 - b. communicated to the CM/GC for resolution in writing,
 - c. communicated to the Engineer for resolution.
 - 3. Should the Contractor fail to coordinate, intervene, and communicate the issue(s) to the aforementioned parties, it shall be the responsibility of this Contractor to correct such issues at the sole burden of this Contractor.

Note: It is understood and acknowledged that this Contractor cannot and shall not be held accountable for items of this nature, prior to this Contractor's authorized involvement in this project.

- F. Products furnished and/or installed by others requiring integration to the system

1. Products furnished and/or installed by others requiring integration to the system, e.g. Owner provided displays or projectors shall be fully integrated into the system.
2. Coordinate with the provider of products.
 - a. Provide all needed interconnecting cabling and connectivity.
 - b. Provide all needed programming.
 - c. Locate all associated devices and materials to facilitate effective integration.
 - d. Coordinate with the Electrical Contractor to assure effective placement of any supporting infrastructure provided by EC.
 - e. Coordinate with the General Trades to assure effective placement of backing or other materials required.

1.2. DESCRIPTION

- A. The system shall provide the ability to capture audio presented to the system by means of microphones or other direct input devices.
- B. The system shall provide playback of recorded audio by means of dedicated speakers at the front of the room.
- C. The system shall provide vocal reinforcement by means of microphones or other direct input devices whether recording or acting as vocal/instrumental reinforcement.
- D. The system shall provide functionality consistent with that of the Classroom Sound Reinforcement Systems by leveraging ceiling mounted speakers and a lavalier microphone for the teacher. This functionality shall be available through the mixer should the desire be to record teacher feedback while students perform and are recorded.

1.3. PRODUCTS INCLUDE

- A. Products include, but are not limited to,
 1. Audio Capture/Player
 2. Optical Player
 3. Microphones
 4. Mixers
 5. Amplifier
 6. Speakers
 7. Connectivity
 8. Cabling
 9. Cabinet
 10. Assorted Related Hardware
 11. Software and Licenses
- B. Refer to the Drawings for additional information and requirements.

1.4. RELATED DOCUMENTS

- A. Related Standards: All requirements of the latest published editions of the following standards and/or codes shall apply, unless otherwise noted. In the event of conflict between cited or referenced standards, the more stringent shall govern.
 1. ANSI/INFOCOMM IM-2009 Audio Coverage Uniformity
 2. ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification Guide
 3. AVIXA F501.01:2015 Cabling Label for Audiovisual Systems

4. AVIXA F502.01:2018 Rack Building for Audiovisual Systems
5. RP C303.01:2018 Recommended Practices for Security in Networked Audiovisual Systems
6. NFPA 70 – The Nation Electric Code

B. Related Sections

1. Section 27 01 00 – Communications Common Work Results
2. Section 27 05 24 – Technology Firestopping
3. Section 27 05 26 – Grounding and Bonding for Communications Systems
4. Section 27 05 28 – Pathways for Communications Systems
5. Section 27 05 36 – Cable Trays for Communications Systems
6. Section 27 11 00 – Equipment Room Fittings
7. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
8. Section 27 15 13 – Communications Copper Horizontal Cabling
9. Section 27 41 16 – Classroom AV System
10. Section 27 41 17.1 – Gymnasium Audio Visual Systems
11. Section 27 41 17.2 – Dining Area Audio Visual Systems
12. Section 27 41 17.8 – Miscellaneous Audio Visual Devices and Systems
13. Section 27 51 23 – Central Sound and Paging

1.5. QUALITY ASSURANCE

A. Qualifications:

1. Bidder Qualifications: To ensure the chosen bidder has the long-term interests of Owner in mind, the following shall be required to submit at bid time for this project. Failure to submit acceptable responses to any/all requirements shall be sufficient reason to eliminate a bidder from consideration. The Owner, in its sole discretion, shall reserve the right to waive any or all the requirements listed below on an individual basis.
 - a. Bidder shall have a history of completing projects of like size and complexity for a minimum of 5 years.
 - b. Bidder shall provide a list of a minimum of three (3) facilities (facility, contact name, title, address and current phone number) where the bidder has provided equipment and services of equivalent brand, size and scope within the last 3 years
 - c. Bidder shall provide a minimum of one (1) facility (facility, contact name, title, address and current phone number) where the bidder has provided equipment and services of equivalent brand, size and scope that is at least five (5) years old.
2. Manufacturer Qualifications: At least 5 years of documented experience in the production of the specified products or as approved by Owner.

B. General:

1. Contractor shall Install all equipment, devices and cabling in compliance with all associated Codes and Regulations, and with the highest degree of workmanship in conformance with the documented standards and industry best practices that apply to these applications.
2. Contractor shall field verify all work site conditions, including dimensions and site lines prior to submitting shop drawings.
3. As stated elsewhere in these documents, the Contractor shall be knowledgeable in and perform all installation procedures in accordance with the current release of NFPA 70, the National Electrical Code, as well as any other applicable code or regulations. Furthermore, all materials utilized in this installation shall be new and UL listed for the application for which it is being utilized.

4. The installation shall be neat and orderly and in accordance with the highest quality as documented in all current governing and industry standards as relating to the installation of said systems, including, but not limited to, NICET, IEEE, EIA/TIA, and BICSI.
 5. All terminations and programming shall be completed by technicians trained and certified by appropriate parties, including, but not limited to, InfoComm/AVIXA and the manufacturers from whom the various components are manufactured, as well as previously experienced in completing these tasks.
 6. System performance and operational expectations have been developed by using the products Specified herein. Should the bidder wish to provide, AS A VOLUNTARY ALTERNATE, substitutions for these materials whether through formal substitution during bidding, as or a cost reduction measure after Contract assignment, they shall provide the following for evaluation:
 - a. During the bidding process, the bidder shall follow defined material substitution requests as outlined in the Division 0/1 Specifications and Related Documents, provide all required materials, and in the timetable allotted,
 - b. The bidder/contractor shall be responsible to provide for review and approval, all calculations and/or performance modelling and simulations to substantiate requested substitutions. All audio performance predictions shall be created in EASE for compatibility of that software used by the design team to create the baseline model.
 - c. The bidder/contractor shall provide line item detailed cost savings for a complete list of all items required to both provide complete uniformity of design as well as required modifications to the design to fulfill the intent of the design.
 - d. The bidder/contractor shall provide data sheets clearly indicating the proposed materials being substituted for all materials being substituted containing all pertinent and salient performance data.
 - e. The Engineer/Owner retains the right to reject proposed substitutions and require those materials, equipment and work as initially specified.
- C. Review all architectural, structural, electrical, and other project documents relative to this work.
- D. Verify all dimensions and site conditions prior to starting work.
- E. Coordinate the specified work with all other trades.
- F. Maintain a competent on-site supervisor and supporting technical personnel, acceptable to the Owner during the entire installation. Change of supervisor during the project shall not be permitted without prior written approval from the Owner. On-site supervision shall be provided by a member of the contractor's regular full-time staff who holds a current certified technology specialist - Integrator (CTS-I) as offered through AVIXA/InfoComm International. Lack of a qualified on-site supervisor as defined herein shall, at the discretion of the Owner, be deemed sufficient reason to consider in breach of the Contract.
- G. Provide all items express or implied on the drawings or in the specifications that are necessary, required, or appropriate for this work to realize a complete and fully operational system that performs in stable and safe manner.
- H. Review project documentation and continuously make known any conflicts discovered and provide all items necessary to complete this work to the satisfaction of the Owner without additional expense. In all cases where a device or item or equipment is referred to in singular number or without quantity, each such reference shall apply to as many such devices or items as are required to complete the work.

- I. Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner, without additional cost to the Owner.
- J. Regularly examine all construction, and the work of others, which may affect Contractors work to ensure proper conditions exist at site for the equipment and devices before their manufacture, fabrication, or installation. Contractor shall be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.
- K. Promptly notify the Owner in writing of any difficulties that may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable in all ways to receive this work, except for defects that may develop in the work of others after its execution.
- L. After installation, submit photographs showing cable entries and terminations within equipment racks, enclosures, and pedestals at the job site.

1.6. CONTRACTOR QUALIFICATIONS

- A. The Contractor or sub-Contractor if so executed shall currently maintain a locally run business within a 100-mile radius for a minimum of five years, and shall be an authorized distributor and service center for the supplied equipment having full warranty privileges.
- B. The Contractor or sub-Contractor if so executed shall maintain at his facility the necessary spare parts in the proper proportions as recommended by the equipment manufacturer to maintain and service the equipment being supplied. These facilities and inventory shall be made available for inspection by the Engineer.
- C. Full time qualified staff personnel shall be responsible and execute all programming, configuration and training. Subcontractors for the programming, configuration and/or training purposes shall not be acceptable, and may, at the discretion of the Owner, disqualify the bidder's bid submission.
- D. At the time of bid submission, the Contractor or sub-Contractor if so executed shall have manufacturer specific certifications, with regard to programming, installation, troubleshooting and servicing, for the system components being provided, in particular certifications for the Digital Signal Processors, Digital Mixing Consoles and Amplifiers, as well as an Infocomm Certified Technology Specialist – Installer (CTS-I) who shall act as the on-site foreman, and an Infocomm Certified Technology Specialist – Designer (CTS-D) who shall act as on staff engineering support. Furthermore, all Dante programming and configuration shall be performed by an Audinate Level 2 Certified technician.
- E. The Contractor or sub-Contractor if so, executed shall have a minimum of five installations of like magnitude and complexity within the last three years.
- F. After installation, submit photographs showing cable entries and terminations within equipment racks, enclosures, and pedestals at the job site.

1.7. SUBMITTAL REQUIREMENTS

- A. Contractor shall be required to provide submittals and shop drawings to Owner within twenty (20) calendar days of date of award notice, acknowledged with a binding letter of intent. Contractor shall

be responsible to ensure that the dimensions and specifications of each component and all systems fit within the building allowances. The Owner, Architect and Engineer must review and approve all submittal documents prior to the start of work. Contractor shall advise the Owner of any discrepancy that could affect installation. If Contractor fails to notify Owner of any discrepancies, Contractor shall assume responsibility for providing the required equipment or correcting such discrepancies at no additional cost to Owner.

- B. Submittals that are incomplete, deviate significantly from the requirements of the Contract Documents, or contain numerous errors will be returned without review for rework and re-submittal, and may result in back charges to the contractor
- C. Approval of submitted items indicates only the acceptance of the manufacturer and quality. Specific requirements, arrangements, and quantities shall comply with the intent of the Contract Documents as interpreted by the Owner unless specifically approved in writing
- D. Submittals shall be provided digitally in PDF electronic file format and include Contractor's approval.

1.8. ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Provide a complete LIST of proposed equipment with reference to its corresponding specification paragraph number or equipment title in specification paragraph order. Where multiple devices can utilize the same product data sheet, provide individual submissions for each device specifically hi-lighting or otherwise making the specific selection obvious to the reviewer that information which specifically applies to the device for which the submission is being provided.
 - 2. Provide preparation instructions and recommendations.
 - 3. Provide storage and handling requirements and recommendations.
 - 4. Provide installation methods.
- B. Shop Drawings: For all speakers, speaker clusters, equipment racks and related equipment.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include detail drawings of all custom fabricated items and approved equipment modifications.
 - 3. Include complete parts lists, schematic diagrams, and all dimensions required for proper assembly.
 - 4. Include component weight and power calculations.
 - 5. Include point-to-point wiring diagrams from initial signal source to final signal destination and typed wire schedule identifying every connection and cable utilizing an Owner approved cable identification scheme. Include in schedule cable type and gauge. Include all intermediate electronic devices such as all electronic components, transceivers, switches, transformers and terminal blocks. Indicate locations of all components. Identify cables by type, color, and cable identification.
 - 6. Submit conduit riser diagrams showing required conduits and junction boxes along with fill including types and quantities of cables to be contained in each conduit. Where existing pathways are utilized indicate such re-utilization and restate the specifics of that pathway as to size, etc. as well as any current contents of pathway. Show details of weatherproofing, lightning protection and grounding, strain relief and cable support, fire stop protection, and wall penetrations through all rated partitions.

7. Submit rack layouts indicating the proposed arrangement of mounted equipment including power junction box location. Rack layouts shall be dimensionally accurate and include front and rear views.

1.9. INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Manufacturer and Installer
 1. Submit a list of all lower tier subcontractors and suppliers. List shall include lower tier subcontractor's qualifications indicating performance of similar work on past projects of this type and scope, as well as indicating any special certifications associated with said work, e.g. submit a copy of the certification(s) held by the party responsible for the termination and testing of the fiber optic system. The Owner reserves the right to reject any subcontractors without reservation or cause and shall have the final authority on such rejections.
- B. Product Test Reports: For each type of equipment, for tests performed by a qualified testing agency.
- C. Product Certificates: For each type of equipment.
- D. Project Schedule: Outlining equipment delivery dates and installation start and finish dates. Project schedule shall be broken down into sufficient detail (work task and duration) to permit Owner to monitor installation progress on a daily basis. Include required approval dates by Owner/Architect.
- E. Field quality-control reports.
- F. Sample Warranty: For all manufacturer's special warranties and system warranties.
- G. Copies of all required business and contractor licenses.
- H. Proof of Insurance

1.10. CLOSEOUT SUBMITTALS

- A. In addition to any close-out requirements that may defined elsewhere in these Documents, when the installation is substantially complete including the Testing Reports in Part 3 of this Section, Contractor shall submit two (2) complete initial hard copy sets of the closeout submittals as listed below to the Owner and Engineer for review and approval. After review and approval of initial set, Owner shall return one (1) initial hard copy to Contractor with comments for updating. Contractor shall provide four (4) final sets of closeout submittals to Owner and one (1) electronic copy in PDF format. Closeout submittals shall include, but not be limited to:
 1. Project Record Drawings (As-Built Drawings) including, but not limited to:
 - a. electrical drawings,
 - b. device and equipment schedules,
 - c. system block diagrams,
 - d. system wiring diagrams,
 - e. rack layout drawings,
 - f. custom fabricated signage drawings (final fabrication version)
 - g. testing and commissioning data formalized into a report format
 2. An Operation and Maintenance Manual.
 3. Full documentation of all programming provided, including, but not limited to, initial configurations settings and system presets or other operational settings in a robustly commented pre-compiled format, or for those pieces of equipment programmed through a

- graphical programming interface full graphic configuration with a types listing of any calibrations or settings input for any graphic element not explicitly listed in the graphic.
4. Provide two (2) copies of electronic backups of all programming and configuration executed.
 5. A schedule of all equipment provided and its location within the facility. List shall include manufacturer name, model identifier, serial number, firmware versions and any other pertinent information needed to obtain service, maintenance, and/or replacement.
 - a. For all devices and equipment utilizing an Ethernet based transport, include the MAC addresses.
 - b. For all devices and equipment that utilize TCP/IP routing protocol, include the internet protocol addresses.
 - c. For all devices and equipment that utilize any other addressable protocol(s), include the names, addresses and/or any other unique information utilized to track and/or communicate with the devices or equipment.
 6. Provide a list of ALL passwords for programming, administration and control features and functions for all hardware and software. Submission of the form to be included shall be sufficient for the engineering review copy of this document, as it will only be necessary to provide the passwords to the Owner.
 7. Provide three (3) sets of all keys for each locked piece of equipment.
 8. A list of all Subcontractors who performed work for Contractor during installation. List shall include company name, physical company address, phone number, and contact person(s), as well as the scope of work provided by the subcontractor.
 9. Documentation certifying old equipment and associated support structures that were demolished by Contractor prior to the installation of new equipment have been properly disposed or recycled per local, provincial, and/or federal law(s).
 10. Test reports from an independent testing & inspection agency certifying that bolted and/or welded connections for primary and/or secondary structural steel meet the minimum requirements of the engineered structural drawings, the governing building code, or as required by the building official; whichever is more restrictive.
 11. All testing and commissioning reports as specified in Part 3 below.
 12. Warranty Documentation, including, but not limited to, specific warranty verbiage from the various manufacturer, durations for each device covered, as well as start date(s), and copies of any/all documents submitted to the manufacturer on behalf of warranty commencement.

1.11. OPERATION AND MAINTENANCE MANUAL

- A. Upon substantial completion and prior to onsite training with the Owner, Contractor shall provide four (4) final hard copies and one electronic copy Operation and Maintenance Manuals (O&M Manuals).
- B. Electronic files shall be in .pdf format, except for drawings which shall be in .DWG format, and programming files which shall be in the native format of the programming software within which it was created pre-compiled a heavily commented.
- C. O&M Manuals shall have tab dividers and shall be logically organized to provide easy access to information without the need to research through entire manual.
- D. All documents provided in the O&M Manual shall be written in English and shall provide sufficient detail as to be understood by an individual with no knowledge of LED displays or the associated control equipment and/or operating systems.

E. Contents of the O&M Manual shall include, but not be limited to:

1. Table of Contents
2. Description of system(s) including key features and operational procedures.
3. Full start up procedure for all equipment written under the assumption that all equipment was in full powered off mode.
4. Full shutdown procedure for all equipment written under the assumption that the facility is in fully powered up use
5. Troubleshooting procedures for DSP's, amplifiers, Dante network devices and equipment, and all related equipment provided by Contractor. Troubleshooting procedures shall include demonstration photos and/or diagrams as required.
6. Maintenance procedures for DSP's, amplifiers, Dante network devices and equipment, and all related equipment provided by Contractor. Maintenance procedures shall include demonstration photos and/or diagrams as required. Contractor shall indicate whether maintenance procedures should be performed monthly, bi-annually, or annually.
7. Owner's Manuals for all third party and/or "off the shelf" type equipment provided by Contractor; e.g., KVM's, fiber modems, network switches/routers, and UPS battery back ups
8. All third-party equipment and/or "off the shelf" equipment warranties and a notarized System Warranty.
9. Instructions for alternative control operations for intramural or other non-game day use by untrained university staff.
10. Hard copy listings and electronic copies transferred to a USB connected mass storage device of all programming code and configuration software data files in a pre-compiled format capable of being opened and modified in the standard software utilized to do the initial programming.

1.12. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products in strict compliance with the manufacturer's instructions and recommendations, as well as industry standards.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store materials within absolute limits for temperature and humidity recommended by manufacturer. Protect from damage.

1.13. SEQUENCING

- A. Ensure that information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress. Coordinate with the General Contractor for the associated infrastructure bid package to assure effective and complete installation of work.

1.14. PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results.
- B. Verify field measurements prior to commencement of work.
- C. Do not install products under environmental conditions outside manufacturer's absolute limits.

- D. Do not install suspended products and/or products located on the catwalk until contractor responsible for any/all structural modifications has completed work impacted by such additions of weight and/or structural stresses.
- E. Products shall not be installed until painting and other finish work is complete.

1.15. WARRANTY AND SERVICE

- A. Contractor shall warrant all labor and materials for twenty-four (24) months following the date of Final Acceptance.
- B. During the warranty period the system shall be free of defects and deficiencies and conform to the drawings and specifications with respect to the quality, function, and characteristics stated.
- C. Contractor shall repair or replace all defects that occur in labor or materials within the warranty period. On-site labor shall be included during the warranty period. Any/all warranty replacements and repairs shall not lessen or terminate subsequent warranty for all material and labor for the entirety of the system including those materials either repaired or replaced.
- D. Failed parts whose replacement is performed without onsite intervention by the Contractor shall be returned to the Contractor for repair at a service facility located in the United States. Contractor shall identify the location of its service facility in the documentation provided when submitting a bid for this work.
- E. The Contractor shall replace failed parts that cannot be repaired.
- F. Upon receipt of a failed part, Contractor shall return a repaired or replacement part to the Owner within fifteen (15) business days from receipt of failed part. Replacement parts shall be new, or like new and operational as if new.
- G. The Contractor shall be responsible for providing the following emergency response availability:
 - 1. Telephone service assistance and technical support including remote system connections for problem diagnostics and programming/operational issue resolution.
 - 2. A parts exchange program, including advance parts replacement via same day shipment. The manufacturer shall keep a ready stock of key assemblies available to ship out upon notice of a parts failure if part is not available in spare parts inventory at Owner's facility.
 - 3. During the warranty period all devices and equipment necessary for the ongoing operation of the scoreboard shall be available to be provided as an advanced replacement. The advance replacement should contain all of the shipping information and packaging necessary to return the defective part or assembly back to Contractor at no cost to the Owner.
- H. The Contractor shall supply at least one local service employee or local authorized service agent for servicing and repair of all equipment during the warranty period. Local service employee or local authorized service agent shall be located within 200 miles of Owner's facility.
- I. The local service employee or local authorized service agent shall, when required, provide on-site support within 24 hours of notification.
- J. The local service employee or local authorized service agent shall maintain at their office/service depot a stock of the most common components that may require replacement. The stock shall be

maintained and shall be eligible as previously define in this Section as advance replacement stock. And, when necessary, shall act as same with the manufacturer replenishing their local service stock instead or requiring a second site visit and system replacement.

- K. Warranty shall cover all equipment, including processors, controllers, operating systems, and software.
- L. Warranty shall include two annual on-site system check-ups by a qualified technician who is a full-time employee of the Contractor. Visit to occur approximately 2-3 weeks prior to the start of the second and third seasons or as determined by Owner.
- M. Check-up shall include all regular maintenance; including filter changes, a complete inspection of all systems, system performance level based on original calibrations, parts replacement where required and a complete written report of all findings.
- N. Following the warranty period, a separate service agreement will be pursued at the owner's discretion.

PART 2 - PRODUCTS

2.1. PRODUCT SUBSTITUTIONS

- A. As indicated elsewhere in these documents, the products specified on these Construction Documents are to be furnished as indicated. Substitution of materials or products considered to be functionally equivalent, where not previously approved in writing by the Engineer, shall be unacceptable. Any deviation from the use of materials or products shall be handled in accordance with terms and conditions established elsewhere in the documents.
- B. Where product specified has become permanently unavailable, the Contractor shall submit a current equal product from the same manufacturer with an equal or greater functionality at no additional cost to the Owner. The Owner shall retain the right to refuse any substitution that they deem unacceptable, causing the Contractor to re-submit until an acceptable replacement has been presented.

2.2. PRODUCTS

- A. General
 - 1. All products shall be new, UL listed and comply with all applicable Federal, State and Local regulations.
 - 2. Products listed are reflective of the representational riser diagrams included in the Drawings. The AV Contractor shall modify quantities and configuration to adapt to actual devices required or adapt to any equipment substitutions of any given room.
- B. Equipment
 - 1. Audio Capture/Player
 - a. Disk Formats and File Systems:
 - 1) Disk: CD-DA, CD-ROM, CD-R,
 - 2) USB: FAT16 and FAT32
 - b. File Formats: .cda, .wav, .mp3
 - c. SNR: >90 dB (A-weighted)
 - d. Frequency Response: 10Hz – 20kHz
 - e. THD: 0.01%

- f. Dynamic Range: > 85dB
- g. Channel Separation: >80dB
- h. Outputs:
 - 1) Unbalanced: RCA, >10k Ω , 2 Vrms @ 10k Ω
 - 2) Balanced: XLR, >10k Ω , +4dBu
- i. Remote Control: IR, RS-232C, IP
- j. Bluetooth:
 - 1) Version 4.0
 - 2) Codecs: SBC, MP3
 - 3) Range: 82 ft.
- k. File Folder Limits:
 - 1) Storage Capacity: $\leq$ 2TB
 - 2) File Size: $\leq$ 2GB
 - 3) File Name Length: $\leq$ 255 Characters
 - 4) Number of Files: $\leq$ 999/Folder
 - 5) Number of Folders: $\leq$ 999
 - 6) Number of Folder Levels: $\leq$ 8
- l. Manufacturer and Model:
 - 1) Denon-900R, equal by Tascam or Yamaha
- 2. CD Player/Bluetooth Streaming Device
 - a. The player/dock shall have the following features:
 - 1) Play audio CD's, MP3 CD's and WAV file CD's.
 - 2) User selectable Bluetooth device connection
 - 3) CD TEXT and ID3 tag support.
 - 4) Continue, Random and Program play modes.
 - 5) Repeat all and Repeat Single play modes.
 - 6) Index search.
 - 7) Shock/skip prevention memory buffer.
 - 8) $\pm$ 12% pitch control (analog outputs only)
 - 9) RCA unbalanced line outputs for CD
 - 10) Coaxial and Optical S/PDIF digital audio outputs. (CD Only)
 - 11) 1/4" stereo headphone jack.
 - 12) 19" rack mountable.
 - 13) IR remote control.
 - b. The unit shall be compatible with the following disc formats:
 - 1) CD-DA (12cm/8cm)
 - 2) CD-ROM (12cm/8cm)
 - 3) ISO 9660 LEVEL 1/2/ROMEO/JOLIET format (CD-R/CD-RW DISC compatible)
 - c. The unit shall conform to the following playback specifications:
 - 1) MP3
 - a) Audio mode: Stereo, Joint Stereo, Dual Channel, Mono
 - b) Sampling Frequency: 32 kHz, 44.1 kHz, 48 kHz
 - c) Bit Rate: 32kbps – 320 kbps and VBR
 - 2) WAV
 - a) Sampling Frequency: 8 kHz, 11.025 kHz, 12 kHz, 16 kHz, 22.05 kHz, 24 kHz, 32 kHz, 44.1 kHz, 48 kHz
 - b) Sampling Bit Rate: 8 bit, 16 bit
 - 3) Audio CD Playback
 - a) Sampling Frequency: 44.1 kHz
 - b) Sampling Bit Rate: 16 bit

- c) Number of Channels: 2
 - d. The unit shall have a minimum of the following connectivity:
 - 1) Aux In (Unbalanced)
 - a) Connector: 3.5mm stereo mini jack
 - b) Reference Input Level: -16dBV
 - c) Maximum Input Level: 0 dBV
 - d) Input Impedance: 22k
 - 2) Analog Output (Unbalanced)
 - a) Terminal Connector: RCA pin jack
 - b) CD Ref Output Level: -10 dBV
 - c) CD Max Output Level: +6 dBV
 - d) Output Impedance: 200 Ohms
 - 3) Phones
 - a) Connector: 1/4" stereo jack
 - b) Max Output Level: 20 mW + 20 mW
 - c) Load Impedance: 32 Ohms
 - 4) Digital Output (Optical)
 - a) Connector: Optical jack
 - b) Compatible signal format: IEC-60958 Type II (S/PDIF)
 - 5) Digital Output (Coaxial)
 - a) Connector: RCA pin jack
 - b) Compatible signal format: IEC-60958 Type II (S/PDIF)
 - 6) Video Output:
 - a) Connector: RCA pin jack
 - b) Compatible signal format: Composite video signal
 - c) Output Impedance: 75 Ohms
 - 7) S-Video:
 - a) Connector: 4 pin-mini DIN
 - b) Compatible signal format: Separate video signal
 - e. The unit shall have the following CD playback audio performance:
 - 1) Frequency response: 20 Hz – 20 kHz $\pm$ 1.5dB
 - 2) Signal to Noise Ratio: More than 90 dB (20 kHz LPF + A weighted.
 - 3) Dynamic range: More than 90 dB (20 kHz LPF + A weighted.
 - 4) Total harmonic distortion: Less than 0.01% (1 kHz, 20 kHz LPF)
 - 5) Channel separation: More than 90 dB (1 kHz, 1 kHz BPF)
 - f. The units backup memory shall store the following information:
 - 1) Time and title display settings (CD)
 - 2) Playback mode (CD)
 - 3) Program (for loaded CD)
 - 4) Current folder (for loaded CD)
 - 5) Output source setting
 - 6) Repeat setting (CD)
 - 7) Pitch control ON/OFF (CD)
 - 8) Pitch control value (CD)
 - g. Wireless streaming shall support the aptX codec
 - h. The unit shall mount on a stand 19" rack mount rail system.
 - i. Acceptable Manufacturer and Model shall be:
 - 1) TASCAM CD-200BT, or equal by Denon or Panasonic
- 3. Microphones
 - a. Wired
 - 1) Microphone shall be ceiling mounted with directional mounting attachment.

- 2) Element shall be fixed-charged back plates with permanently polarized condenser.
 - 3) Frequency response shall be 30-20,000 Hz
 - 4) Low frequency roll off shall be @ 80 Hz w/ 18dB/octave
 - 5) Open circuit sensitivity shall be -40 dB re:1V at 1 Pa
 - 6) Maximum input sound level shall be 138 dB SPL, 1kHz at 1% THD
 - 7) Manufacturer and model shall be:
 - a) Audio Technica ES933, equal by Shure or Sennheiser
 - b. Wireless
 - 1) Performance Metrics:
 - a) Dynamic Range: >115 dB A weighted, typical
 - b) Output: XLR Balanced +14 dBV minimum
 - c) THD: <1.0%, 1kHz, ±17.5 kHz
 - d) Modulation: FM
 - e) Operating Sensitivity: 20dBuV @ 60dBA SNR
 - f) Channel Config: 40 Channels/band minimum, Frequency Agile, 25kHz Channels
 - g) Spectrum: UHF, coordinate availability in band with local licensing and conditions
 - h) Operating Range: 100m, open field
 - 2) Manufacturers and Series
 - a) Audio Technica 3000 Series,
 - b) Equivalent product by: Shure, Sennheiser
 - 3) Receivers:
 - a) ATW-3211 Series (470-530 MHz) – Provide 3
 - 4) Handheld
 - a) ATW-T3212 Series (470-530 MHz) – Provide 2
 - b) ATW-C510 Cardioid Dynamic Microphone Capsules – Provide 2
 - 5) Lavalier
 - a) ATW-T3201 Body-Pack Transmitter – Provide 1
 - b) AT831cH Lavalier Microphone – Provide 1
 - 6) Charging System
 - a) As manufactured by the manufacturer of the microphone system. Provide either individual chargers or multiple charger units for 100% of the battery powered devices being provided.
 - 7) Antenna System
 - a) As recommended by the manufacturer
 - c. Microphone Stands
 - 1) Floor Stand
 - a) Adjustable 36” – 60” chrome stand with 10” diameter round base, rubber feet, and minimum 9 pound weight – Provide 1
 - 2) Manufacturers
 - a) Atlas Soundolier
 - b) Proline
 - c) Shure
4. Mixer
 - a. The mixer shall be a rack mountable form factor
 - b. The mixer shall be a modular design, with a minimum of 10 mic/line inputs with balanced XLR/TRS jack, insert and direct output

- c. The mixer shall have a minimum of 6 aux sends, switchable between pre and post fade
- d. The mixer shall have a minimum of 2 stereo inputs
- e. The mixer shall provide +48V phantom power.
- f. The mixer shall have 100mm faders
- g. Acceptable manufacturer and model shall be:
 - 1) Allen & Heath MixWizard WZ4 14:4:2
 - 2) Or equal by Presonus or Mackie
- 5. Amplifier
 - a. Configuration: 2 Ch
 - b. Sensitivity: 1.4V
 - c. Power Output: 300W/Ch
 - d. Input Impedance : >20k Ω
 - e. Output : 70V
 - f. Frequency Response : 20 Hz – 20 kHz
 - g. THD <0.5% @ 1kHz
 - h. SNR 100 dB, 20 Hz – 20kHz
 - i. Processing : Integrated DSP
 - j. Manufacturer
 - 1) Crown, LEA, QSC
- 6. Speakers
 - a. Left/Right
 - 1) The speaker shall be a minimum 2-way full range speaker enclosure.
 - 2) The speaker shall be constructed of a minimum of 18mm plywood with a polyurethane finish coat.
 - 3) The speaker shall have 8 ohm direct coupled connection.
 - 4) The speaker shall have the following performance criteria:
 - a) Frequency Response: 37 Hz – 19kHz
 - b) Sensitivity (SPL 1W/1m): 94 dB
 - c) Max Calculated SPL: 122 dB Continuous/128 db Peak
 - d) Long Term Power Handling: 600W
 - e) Horizontal Coverage: 90°
 - f) Vertical Coverage: 50°
 - g) Nominal Impedance: 8 Ohms
 - 5) Acceptable Manufacturer and Model shall be:
 - a) Community IP6-1122, equal by JBL or QSC
 - b) Provide mounting hardware as recommended by speaker manufacturer for mounting from the wall, including, but not limited to all required secondary supports.
 - b. Ceiling
 - 1) Configuration: Two way 6.5" LF Driver, .75" HF Driver
 - 2) Nominal Dispersion Pattern: 120° Conical
 - 3) Frequency Range: 70 Hz – 13.5 kHz
 - 4) Power Handling: 60W continuous @ 8 Ω
 - 5) Transformer: 70V/100V 30W, 15W, 7.5W, 3.75W
 - 6) Output: 109 dB continuous, 115 dB Peak
 - 7) Sensitivity: 91dB 1W/1M
 - 8) Mount: ceiling recessed
 - 9) Finish: White from factory, coordinate with architect and paint to match as may be necessary
 - 10) Manufacturer and Model

- a) Community C6, equal by JBL, QSC

C. Connectivity

1. Cabling

a. Microphone

- 1) All microphone cable shall be UL rated.
- 2) All microphone cable shall be 22 AWG stranded copper wire.
- 3) All microphone cable shall be low capacitance.
- 4) All microphone cable shall have a continuous foil shield with drain conductor.
- 5) Acceptable Manufacturer and Model shall be:

- a) West Penn:

- (1) D25291 plenum
- (2) 77291 non-plenum

- b) Or equivalent product by Liberty Wire and Cable or Belden

b. Speaker

- 1) 12 AWG stranded copper wire.
- 2) Acceptable Manufacturers
 - a) West Penn:
 - (1) 12 AWG 25227 plenum
 - (2) Or equivalent product by Liberty Wire and Cable or Belden

c. Patch Cords:

- 1) Provide all indicated or as may be required for complete connection of all system components
- 2) All terminations shall be tinned with solder prior to termination, and solder to their connector where the means of connection can withstand such process.
- 3) All patch cords for network connections shall comply with Section 27 15 13 Communications Copper Horizontal Cabling, and match the manufacturer provided under the structured cabling scope of work.
- 4) All audio patch cords shall match the gauge of the cabling being provided for the balance of the cabling run, and be terminated with a mechanical means assuring disconnection and reconnection consistency.

2. Wireless AV Extenders

- a. Compatible with Windows, MAC, iOS and Android
- b. Wireless Point to Point connection.
- c. Capable of receiving video with a minimum of 1080p/60 with stereo audio.
- d. Provides a canvass capable of concurrently up to 4 simultaneous video inputs.
- e. Compliant with HDCP 2.3.
- f. Acceptable Manufacturer and Model:
 - 1) Barco Clickshare CX-20, Extron eLink 100, Crestron AM-200

3. Receptacle Stations and Related Hardware

- a. Standard Faceplates: Brushed Aluminum, as manufactured by ProCo, Panelcrafters/Liberty A/V or Switchcraft.
- b. Speaker Faceplate Connector
 - 1) Rated Current per contact: 30 A RMS Continuous
 - 2) Rated Voltage: 250 V
 - 3) Lifetime: 5000 mating cycles
 - 4) Contact Resistance: $< 3 \text{ m}\Omega$
 - 5) Connection Type: speakON
 - 6) Acceptable Manufacturer and Model:
 - a) Neutrik NL4MP

4. Bluetooth Receiver: Attero Tech UNBT2A with AXP20 Receiver

5. Transformer: For transforming constant voltage paging from the local zone to line level for input into the audio system.
 - a. Radio Design Labs, TX-70A
6. Hardware
 - a. Equipment Cabinet
 - 1) Black electrostatic finish
 - 2) EIA 19" Rack mount front and rear rails, 10x32 drilled and tapped with visible RU indicator
 - 3) 16 Rack Units high
 - 4) Three section
 - 5) 22.3" Deep
 - 6) Front and Rear locking
 - 7) UL Listed 1678
 - 8) 14 gauge frame, 16 gauge side frame, 14 gauge top and bottom sections
 - 9) Provide 3U drawer with customizable foam insert.
 - 10) Provide lacing brackets vertically at both back corners, and a lacing bar per each component mounted in the cabinet.
 - 11) Acceptable Manufacturer and Model:
 - a) Middle Atlantic DWR-16-22
 - b. Power Distribution Unit
 - 1) PDU shall be horizontal, rack mount, 15A 120V
 - 2) PDU shall provide three duplex receptacles that shall power up and down per safe sequence to protect the equipment in the cabinet, plus one duplex that is non-switched.
 - 3) PDU shall have all connections rear mounted.
 - 4) PDU shall be controllable by a minimum of a discrete closure from the control system, RS-232 control acceptable.
 - 5) Provide 1 per cabinet
 - 6) Acceptable manufacturer and model:
 - a) Furman M8-S
 - c. Grounding
 - 1) 19" x 1/2" x 1/4" thick minimum horizontal ground bar as provided the cabinet manufacturer.
 - d. Miscellaneous Hardware
 - 1) Provide any/all hardware and accessories required to complete the design intent provide, as well as may be required to comply with any/all applicable codes, audiovisual industry standards and best practices, and to assure a safe operational environment.

PART 3 - EXECUTION

3.1. INSTALLATION

- A. The Contractor shall neatly label and dress all cabling to assure easy maintenance and troubleshooting. Within all equipment enclosures, including but not limited to, video equipment racks, the Contractor shall utilize Velcro straps or Milli-Tie wraps for bundling of signal wires. Within all enclosures provide and utilize lacing bars and surfaces to assure neat and trouble-free system operation and maintenance.
- B. All cabling labeling shall be by means machine generated labels that wrap the complete cable diameter. Adhere labels within 6" of each end of the cable ends. Label all speaker cabling at the rack

end with the specific speaker ID. Label all speakers at the speaker end with both the speaker ID and the amplifier ID.

- C. Label all components with the device name derived under Paragraph 3.2 below. Labels shall be machine generated on a self-adhesive tape or phenolic engraved tag.
- D. Rack and stack all cabinets, and/or clusters of equipment in the Contractor's shop in a controlled environment. Verify that the completed cabinets, and/or equipment cluster operates properly prior to transporting the cabinets and/or equipment clusters to the job site for final assembly.
- E. After assembly of the system on site, execute all required programming, calibration, and commissioning to optimize performance of the system within the constraints of the installed environment.
- F. Mount all speakers and other components as either specified or drawn, or for cases where explicit instructions are not given within these Documents, execute all installation to the highest level of industry best practices. After installation of these speakers and other devices are completed, verify all mechanical and electrical connections are executed per recommended by the device manufacturer, and all items are safe and secure.
- G. Fully test the system for component operation, as well as project specific programming. Document the testing procedures and the results of the testing. Submit hard copy of the testing documentation in the Operations and Maintenance Manuals submitted at time of close out.
- H. Equipment Racks
 - 1. The Contractor shall submit to the Engineer for approval, the intended cabinet layouts, prior to installation. Upon written approval of the cabinet layouts the Contractor may proceed with this installation.
 - 2. Cabling shall be routed, combed, and bound neatly as it is routed in the cabinet. Orderly cable bundles shall be grouped and secured to the cabinet structure. Cables shall be provided with enough service loop to enable the contractor to route all cabling up the sides of the cabinet to the height of the device to be connected, and then over to that device.
 - 3. Failure to comply with this requirement shall give the Owner or Engineer the option to require the Contractor re-dress the cabling or remove it in whole and re-install the cabling.

3.2. LABELING

- A. All wires and cables shall be labeled with either a self-laminating label designed for labeling wire and cable, or by wrapping a pre-printer or computer-generated label designed by the manufacturer for this purpose, and by sealing it with clear heat shrink tubing over the entire label.
- B. Failure to comply with this requirement shall give the Owner or Engineer the option to require the Contractor re-dress and re-label the cabling or remove it in whole and re-install and re-label the cabling.

3.3. GROUNDING

- A. This rack shall be bonded back to the nearest available TELECOMMUNICATIONS BUSBAR with a minimum #6 AWG bonding conductor, utilizing a two-hole irreversible lug at both ends of the conductor. Each cabinet or rack shall have an individual homerun bonding conductor. Daisy chaining of the bonding conductor is unacceptable.

3.4. CALIBRATION AND COMMISSIONING

- A. The contractor shall verify signal level and signal integrity during installation and operation of the system. Should it be required to provide sufficient signal to noise ratio, as well as other industry accepted signal levels, the Contractor shall provide distribution or buffer amplifiers to assure these sufficient signal levels.
- B. The Contractor shall balance all signals so that distribution of the signals shall be of a consistent and acceptable level.
- C. All installation and calibration of equipment shall be by qualified and certified personnel. All calibrations shall be checked by appropriate calibration equipment. Calibrations made by authoritative and/or experienced eyes and/or ears is not acceptable.
- D. All calibrations and adjustments shall be documented in machine generated print in a neat and organized fashion for transmission to the Owner. The Engineer reserves the right to review, reject or require modification or further documentation prior to completion of the project.
- E. The Engineer shall be given a minimum of 72 hours' notice prior to all final calibrations and commissioning and reserves the right to observe any and all final calibrations and commissioning. Should such courtesies not be extended to the Engineer prior to the final calibrations and commissioning, the Engineer reserves the right for the procedures to be completely repeated prior to considering job completion.

3.5. WORK COMPLETION

- A. The Contractor shall provide a complete and functioning system, based on the designs as set forth in these construction documents. Any and all equipment, either implied or intentionally omitted from these documents, but generally accepted as being required for the completion of the installation, as represented in these construction documents, shall be provided by the Contractor at no additional cost to the Owner.
- B. Each system component shall be individually tested, as well as tested in the complete system configuration, to assure 100% operability of each, and compatibility of all components. All products and system configurations will be fully tested and operational prior to final payment.
- C. Each system shall be configured and/or equalized/calibrated to optimize performance of the entire system. These configuration and calibrations shall be documented, and entered into either a spreadsheet, word processor, or graphics package for machine generation and reproduction of the aforementioned adjustments to the system and given to the Owner in both electronic formats written onto a CD, and hard copy output. The Contractor shall verify the receipt and comprehension of these documents with the Owner. This documentation release to the owner shall occur prior to any consideration of the job status as being complete.
- D. The Contractor shall provide a copy of all testing documentation to the Owner at the time of system commissioning and training.
- E. The Contractor shall provide all necessary fixed and flexible wire management to achieve a high-quality installation both visually and operationally, and that would be considered to be within the standard practices of good workmanship.

- F. The Contractor shall give a two week notice to the Engineer and Owner prior to system commissioning. The Engineer and Owner reserve the right to be present during the commissioning process to approve system configurations prior to the final punch list.

3.6. TRAINING

- A. The Contractor shall provide four (4) hours training for District's personnel on the operation and maintenance of the system.
- B. Provide two (2) video copies of all training.
- C. The Contractor shall perform formal training with permanent staff personnel under the employ of the Owner.
- D. The Contractor shall schedule the training with the Owner two (2) weeks prior to the training.
- E. The Contractor shall submit a training agenda to the Engineer and Owner prior to the notification for approval. Once the agenda is approved, the training shall be based on that agenda.

3.7. WARRANTY

- A. Warranty of the system, including parts and labor, shall be by the system supplier and manufacturer for all materials and workmanship for a period of three (3) years, or for the duration of the manufacturer's documented warranty whichever is greater. Should for some unforeseeable reason, the installer not be able to complete the term of the warranty, the manufacturer shall bear the complete responsibility of the warranty for both parts and labor and shall appoint a certified service organization to complete the term of the warranty. The manufacturer shall inform the Owner of this appoint in writing. The Contractor shall present assurance of this stipulation from the Manufacturer to the Owner in writing prior to commencement of work. Should the Contractor not provide this written assurance, the Owner shall retain the right, as outlined elsewhere in these Documents, to obtain satisfaction, including but not limited to, financial restitution to the Owner.
- B. The warranty period shall begin after substantial completion of all work, including Technology Bid Package systems, at which time, the installer shall provide service within a 24-hour period after notice by the Owner, for the duration of the warranty.

END OF SECTION 27 41 17.3

SECTION 275123 - CENTRAL SOUND AND PAGING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Contractor shall provide a public address paging system that shall include, but not be limited to, provision of all call and zoned paging, as well as bi-directional communications. Zoning shall include, but not be limited to, partitioning to operate high school/middle school areas, separate from the elementary school area, separate from the commons areas as delineated on the Drawings, as well as within these partitions, each classroom or instructional space. Finally, all calls shall be capable of being processed from each of the administration areas to their associated grade levels only, or as intentionally triggered as an all facility all call.
- B. Contractor shall provide an extension of the District's existing system: Singlewire InformaCast Fusion
- C. Integrated into the system shall also be the required processing and interface for the generation of class change tones.
- D. Access to the system shall be by dedicated handset, as well as, by means of a telephone system interface.
- E. The Contractor shall coordinate and implement all required hardware not specifically required by the network/telephony system to provide a DTMF dialup access and zone routing interface to the phone system.
- F. The system shall provide separate and dedicated local program sources for the high school/middle school area, the elementary school area, and the commons areas as three separate and distinct areas.
- G. The system shall be configured so as to allow dial in from the District's telephony system, which shall be an IP telephony system. This system provider shall provide any necessary interface to allow connection to the system and facilitate DTMF triggers into the system to allow full operational, not programming, access into the system.
- H. The system, in whole, shall be backed up by one or more UPS's as recommended by the manufacturer, to provide uninterrupted service during power outages or irregularities for up to two (2) hours.

1.2 GENERAL REQUIREMENTS

- A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.
- B. The contractor for this work shall be held to have read all of the bidding requirements, the general requirements of division 1, and contract proposal forms, and the execution of this work. The contractor will be bound by all of the conditions and requirements therein.
- C. The contractor shall be responsible for providing a complete functional system including all necessary components whether included in this specification or not.

- D. In preparing the bid, the contractor should consider that no claim will be made against the owner for any costs incurred by the contractor for any equipment demonstrations which the owner requests.

1.3 SCOPE OF WORK

- A. Furnish and install all equipment, accessories, and materials in accordance with these Specifications and Drawings to provide a complete and operating school paging and inter-communications system including but not limited to:
1. Administrative display phone with integrated 4x16 character display, one for each of the administration areas.
 2. Classroom speaker(s), ceiling-mounted unless otherwise noted.
 3. Call initiation switches capable of placing normal, urgent or emergency calls.
 4. Built in Master Clock with 1024 events, 32 Schedules, including Daylight Savings Time, and 32 custom holiday events that can be assigned to any of the 64 multi-purpose zones
 5. Wall-mounted paging horns
 6. Wall and ceiling mounted speakers
 7. Amplifiers as required for multi-speaker zones in common areas
 8. One built-in network interface port for system combining and LAN station-to-station calling and district-wide all-calls
 9. One built-in network interface port for first-time system configuration
 10. Built-in Web Server for full system programming with Quantum Commander
 11. Administrative Web-Browser Application for Programming and System Operation

1.4 RELATED SECTIONS

- A. Section 27 05 00 – Technology Common Work Results
- B. Section 27 05 24 – Technology Firestopping
- C. Section 27 05 26 – Technology Grounding System
- D. Section 27 05 28 – Pathways for Communications Systems
- E. Section 27 15 01 – Structured Cabling System
- F. Section 27 51 75 – Wireless Clock System
- G. Division 1 – General Requirements
- H. Division 7 – Firestopping
- I. Division 9 – Finish Painting
- J. Division 11 – Equipment
- K. Division 26 – Electrical

1.5 REFERENCES

- A. The provisions of these specifications along with all Drawings, Alternates, Addenda, Bulletins, RFP's or other related documents shall be considered an integral part of the scope of work for

this/these Contractor(s). These Documents along with the Division 1 and other related division's documentation shall be examined by this Contractor and any/all sub-contractors prior to submission of their bid.

1.6 SUBMITTALS

- A. Specification Sheets shall be submitted on all items including cable types.
- B. Submit outline drawing of system control cabinet showing relative position of all major components.
- C. Shop drawings, detailing integrated electronic communications network system including, but not limited to, the following:
 - D. Station wiring arrangement
 - E. Equipment cabinet detail drawing
 - F. Submit wiring diagrams showing typical connections for all equipment.
- G. Submit a numbered Certificate of Completion for installation, programming, and service training, which identifies the installing technician(s) as having successfully completed the technical training course(s) provided by the system manufacturer.

1.7 SUBSTITUTIONS

- A. Contractors that wish to submit alternate equipment shall provide the specifying authority with the appropriate documentation, at least 10 business days prior to bid opening. The submitted documentation must provide a feature-by-feature comparison identifying how the proposed equipment meets the operation and functionality of the system described in this specification. Contractor shall provide adequate and complete submittal information, prior to bid date, which shall include but not limited to specification sheets, working drawings, shop drawings, and a demonstration of the system. Alternate supplier-contractor must also provide a list to include six installations identical to the system proposed.
- B. The contractor shall also provide the FCC registration number of the proposed system.
- C. Final approval of the alternate system shall be determined at the time of job completion. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate system at the contractor's expense.

1.8 QUALITY ASSURANCE

- A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
- B. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least 5 years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.

- C. The contractor shall show satisfactory evidence, upon request, that he or she maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain at his or her facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

1.9 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.

1.10 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of manufacturer's latest model.
- B. All equipment both discrete and in full assembly shall comply with the following:
- C. NFPA 70 – The National Electrical Code.
- D. BICSI – Telecommunications Distribution Methods Manual, Latest Revision.
- E. American with Disabilities Act.
- F. FCC Part 15
- G. The system shall be new UL listed.
- H. System shall be installed in compliance with local and state authorities having jurisdiction.

1.11 SINGLE SOURCE RESPONSIBILITY

- A. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and minimum of 10 years' experience in the industry. The supplying contractor shall have attended the manufacturer's installation and service school. A certificate of this training shall be provided with the contractor's submittal.

1.12 SAFETY / COMPLIANCE TESTING

- A. The communications system shall bear the label of a Nationally Recognized Testing Laboratory (NRTL) such as ETL, and be listed by their re-examination service. All work must be completed in strict accordance with all applicable electrical codes, under direction of a qualified and factory approved distributor, to the approval of the owner.
- B. The system is to be designed and configured for maximum ease of service and repair. All major components of the system shall be designed as a standard component of one type of card cage. All internal connections of the system shall be with factory-keyed plugs designed for fault-free connection.

- C. The printed circuit card of the card cage shall be silk-screened to indicate the location of each connection.

1.13 SERVICE AND MAINTENANCE

- A. The contractor shall provide a 5 (five) year equipment warranty of the installed system against defects in material and workmanship. All materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer.
- B. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- C. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufactures: Subject to compliance with requirements specifications, provide the following system:
 - 1. Basis for design: Extension of existing District wide paging system
 - a. Singlewire InformaCast Fusion
- B. The intent is to establish a standard of quality, function, and features. It is the responsibility of the bidder to ensure that the proposed product meets or exceeds every standard set forth in these specifications.
- C. The functions and features specified are vital to the operation of this facility; therefore, inclusion in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.

2.2 EQUIPMENT

- A. CONSOLE
 - 1. Rack-mounted console equipment shall be housed in an enclosure or enclosures sized as required by the system drawn and/or specified herein, with a growth factor of 25%. Utilize a cabinet that shall have a minimum of 40 rack units of EIA standard 19" rack within.
 - 2. Rack System
 - a. Rack Mount System. Shall include the following components:
 - 1) Voice paging gateway
 - 2) SIP based
 - 3) IP-based amplifiers in each TR
 - 3. Program Sources (Provide one set of each per Administrative area, at the reception area.)
 - a. Desktop Paging Microphone
 - 4. Power Amplifiers
 - a. 60-Watt Amplifier
 - b. 125-Watt Amplifier
 - c. 250-Watt Amplifier
 - 5. Basis of Design: Singlewire InformaCast Fusion system

2.3 COMPONENTS AND DESCRIPTIONS

- A. Systems that don't allow processors to be seamlessly integrated via the LAN are not considered equal.
- B. Central Cabinet
 - 1. The Paging System shall contain natively RS232, RS485, USB, and Ethernet ports for communication to any third party system.
 - 2. The Paging System shall contain five open collectors, three dry contacts, and six general purpose inputs for third party system integration or for general panic buttons. It shall be possible to expand inputs or outputs to any number needed.
 - 3. The Paging System central cabinet shall be rack or wall mounted.
 - 4. The Paging System shall contain no moving parts that suffer from wear or that require maintenance.
 - 5. The Paging System shall draw no more than 3.5A of current at full load including all system accessories.
 - 6. The Paging System shall have integrated surge protection for all audio ports and switching/line card ports. Said surge protection shall be replaceable in the field with no need to return parts for repair.
- C. Administrative Display Phone
 - 1. The Paging System shall not require an Administrative console to operate. All system functions shall be accessible via telephone codes from any internal or external telephone.
 - 2. The Paging System optional Administrative telephone shall have the following features.
 - a. Desk & wall mountable
 - b. Minimum 8 line by 20 character back lit display
 - c. Wizard driven menu system for ease of use
 - d. 200 speed dials
 - e. Head set compatible
 - f. Integrated speaker phone for hands free use
 - 3. The administrative telephone display panel shows the time of day and day of week, the current time signaling schedule, and the station numbers and call-in priority of staff stations that have called that particular station. A 3-key response is used to scroll the display, and answer or erase normal, urgent, and security calls. Depending upon the system programming, an administrative station can use display menus to activate zone pages, alarm signals and external functions, as well as select program sources and distribute or cancel a program to any or all speakers or zones.
 - 4. Administrative Display Phones shall have the ability to dial and have the option of dialing either the loudspeaker or phone at each station location.
 - 5. The Administrative Display Phone shall display the classroom number of any station that calls.
 - 6. The display phone shall have "Push-to-Talk: Informacast functionality.
- D. Amplifier
 - 1. The amplifier shall be sized based on the load, per TR.
- E. Tones
 - 1. The Paging System shall have at least 25 tones available for bells, reminders, and other events. Paging System with less than 25 tones shall not be considered.
 - 2. The Paging System shall support WAV type audio files. The user shall be able to add 25+ custom WAV files for use as pre-recorded announcements, bells, reminders, pre-announce

tones, or any other system tone. Paging System not allowing users to add WAV files or do not allow for the use of WAV files for any system tone shall not be considered.

3.

2.4 VOIP TELEPHONE INTERFACE

- A. The Contractor shall provide a SIP VoIP telephone interface and shall program the Paging system to accept calls from the District's VoIP telephone system
- B. The Contractor shall verify exact requirements with the District.

2.5 SYSTEM SPEAKERS

- A. Classroom Speakers shall be Quam: Equals by Atlas, Bogen, Telecor and Rauland-Borg
 - 1. Ceiling Speakers: Drop-In Ceiling Speakers, provide manufacturer's plenum enclosure where required, and ceiling tile bridge or either recommended support mechanism.
 - 2. Provide 8" round speakers with associated ceiling bridges and plenum enclosures in all hard ceilings.
 - 3. Provide pendant mounted speakers, associated mounting brackets and cabling supports in all exposed ceilings.
- B. Hallway Speakers shall be Quam: Equals by Atlas, Bogen, Rauland-Borg or Telecor.
 - 1. Ceiling Speakers: Drop-In Ceiling Speakers, provide manufacturer's plenum enclosure where required, and ceiling tile bridge or either recommended support mechanism.
 - 2. Provide 8" round speakers with associated ceiling bridges and plenum enclosures in all hard ceilings.
 - 3. Provide pendant mounted speakers, associated mounting brackets and cabling supports in all exposed ceilings.
- C. Outdoor / Gym / Locker Room Speakers shall be Atlas Sound: Equals by Bogen, Telecor and Rauland-Borg
 - 1. Wide Dispersion Reentrant Horn Loudspeakers with minimum 15W load.

2.6 SYSTEM PARAMETERS

- A. The communication system shall provide a comprehensive communication network between administrative areas and staff locations throughout the facility. Nonvolatile memory shall store permanent memory and field-programmable memory. A system, which uses a battery to maintain system configuration information, shall not be acceptable.

2.7 SPEAKER CABLING

- A. Plenum cabling shall be provided per manufacturer's recommendation, including Category 6 UTP cabling per Specification Section 271501 and West Penn #357. All terminal connections to be on barrier strips, as indicated on the associated riser diagram. All cables to be labeled by room.
 - 1. Speaker cabling equals by General Cable or Belden.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the installer present, for compliance with requirements and other conditions affecting the performance of the Integrated Telecommunications/Time/Audio/Media System.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. The installation, adjustment, testing and final connection of all conduits, wiring, boxes, cabinets, etc., shall conform to local electrical requirements and shall be sized and installed in accordance with manufacturer's approved shop drawings.

B. Low-voltage wiring may be run exposed above ceiling areas where they are easily accessible.

C. Contractor shall install new rack console at location shown on plans.

1. Solder each speaker line splice and tape each individual wire.
2. Connect remote slave clocks to master clock in console.

D. All Administrative Phones shall be desk- or counter-mounted.

1. Provide standard wall 120V AC receptacle 16" AFF
2. Verify exact location with Architect

E. Speaker and telephone lines run above ceiling and not in conduit shall be tie-wrapped to ceiling joist with a maximum spacing of 8' between supports. No wires shall be laid on top of ceiling tile.

F. Connect field cable to each speaker transformer using UL butt splices for 22 AWG wire.

G. Terminate field wiring on wall adjacent to rack using Telco 110 type blocks or screw terminal strips. Provide neat cross connect system for wiring. Wiring to be labeled to indicate final architectural room number that it services on the Telco block, and no the wire using machine generated labeling permanently affixed to the wall field and/or wire.

H. Rack shall be labeled in numerical order with speaker/phone combinations first, speaker/outside horn combinations last. Labeling and order shall reflect final Architectural room numbers posted outside the rooms. Use three- (3), four- (4), five- (5), or six- (6) digit dialing extensions.

I. Contractor shall provide and program Paging System to accept Lockdown input from Access Control System.

J. On the first school day following installation of the system, the Contractor shall provide a technician to standby and assist in system operation.

K. Mark and label all telephone outlets and/or sets with the graphic room numbers. Label all demarks IDF and MDF points with destination point numbers. Rooms with more than one outlet shall be marked XXX-1, XXX-2, XXX-3, etc. where XXX is the room number.

L. No graphic room number shall exceed the sequence from 000001 through 899999.

1. All outside speakers shall be on a separate page zone and time zone.
2. All zones shall be laid out not to exceed 10 watts maximum audio power zone.

3. All hallway speakers shall be tapped at 1 watt maximum.
4. All outside horns shall be tapped at 7.5 watts maximum.
5. All classroom speakers shall be tapped at ½ to 1 watt maximum.
6. Large rooms, such as cafeterias, shall be tapped at 2 watts maximum.
7. Additional building zones:
 - a. (1) zone for each grade
 - 1) Coordinate exact groupings with District
 - b. Each Gym
 - c. Each Student Dining
 - d. Multi-Use Room
 - e. Exterior paging horns
 - 1) Inclusive of Bus Loop and exterior playground areas
 - 2) Contractor shall provide a separate volume control for this zone

3.3 WIRING

- A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts.
- B. All communication system wiring shall be labeled at both ends of the cable. All labeling shall be based on the room numbers as indicated in the architectural graphics package.
- C. All applicable cabling utilized shall be in full compliance with Section 27 15 01 Structured Cabling System.

3.4 PROTECTION

- A. The contractor shall provide all necessary transient protection on the AC power feed and on all station, lines leaving or entering the building
- B. The contractor shall note in his system drawings, the type and location of these protection devices as well as all wiring information. Such devices are not to be installed above the ceiling.

3.5 GROUNDING

- A. Provide equipment grounding connections for Integrated Telecommunications/Time/Audio/Media System as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- C. Comply fully with the requirements of the Technology Grounding Specifications Section.
- D. The contractor shall provide all necessary transient protection on the AC power feed and on all station, lines leaving or entering the building.
- E. The contractor shall note in his drawing, the type and locations of these protection devices as well as all wiring information.

- F. The contractor shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground buss bar.

3.6 DIVISION OF WORK

- A. While all work included under this specification is the complete responsibility of the contractor, the following division of actual work listed shall occur.
 - 1. The conduit, outlets, terminal cabinets, etc., which form part of the rough-in work shall be furnished and installed completely by the electrical contractor. The balance of the system, including installation of speakers and equipment, making all connections, etc., shall be performed by the manufacturer's authorized representative, and provided as a turnkey package to the Owner.

3.7 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- A. All work described herein to be done by the manufacturer's authorized representative shall be provided by a documented factory authorized representative of the basic line of equipment to be utilized.
- B. As further qualification for bidding and participating in the work under this specification, the manufacturer's representative shall hold a valid C-10 Contractor's License issued by the Contractors State License Board of Ohio. The manufacturer's representative shall have completed at least ten (10) projects of equal scope, giving satisfactory performance and have been in the business of furnishing and installing sound systems of this type for at least five (5) years. The manufacturer's representative shall be capable of being bonded to assure the owner of performance and satisfactory service during the guarantee period.
- C. The manufacturer's representative shall provide a letter with submittals from the manufacturer of all major equipment stating that the manufacturer's representative is an authorized distributor. This letter shall also state the manufacturer guarantees service performance for the life of the equipment, and that there will always be an authorized distributor assigned to service the area in which the system has been installed.
- D. The contractor shall furnish a letter from the manufacturer of the equipment, which certifies that the equipment has been installed according to factory intended practices, that all the components used in the system are compatible and that all new portions of the systems are operating satisfactorily. Further, the contractor shall furnish a written unconditional guarantee, guaranteeing all parts and all labor for a period of five (5) years after final acceptance of the project by the owner.

3.8 INSTALLATION

- A. Plugs disconnect: All major equipment components shall be fully pluggable by means of multi-pin receptacles and matching plugs to provide for ease of maintenance and service.
- B. Protection of cables: Cables within terminal cabinets, equipment racks, etc., shall be grouped and bundled (harnessed) as to type and laced with Velcro wire wraps or Milli-Tie tie wraps only. Edge protection material shall be installed on edges of holes, lips of ducts or any other point where cables or harnesses cross metallic edge.

- C. Cable identification: Cable conductors shall be color-coded, and individual cables shall be individually identified. Each cable identification shall have a unique number located approximately 1-1/2" from cable connection at both ends of cable. Numbers shall be approximately 1/4" in height. These unique numbers shall appear on the As-Built Drawings. All labeling shall be created by a machine generating accessory that is designed specifically for generation of such labeling in a Contracting environment on label stock specifically manufactured for the environment in which it is being used. Utilization of general-purpose office labeling stock shall not be accepted, and upon discovery of same shall be required to be removed and replaced with appropriate labeling.
- D. Shielding: Cable shielding shall be capable of being connected to common ground at point of lowest audio level and shall be free from ground at any other point. Cable shields shall be terminated in same manner as conductors.
- E. Provide complete "in service" instructions of system operation to school personnel. Assist in programming of telephone system.

3.9 TRAINING

- A. The contractor shall provide a minimum of forty (40) hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. Operators Manuals and Users Guides shall be provided at the time of this training.

3.10 DOCUMENTATION

- A. Provide the following directly to the District's Technology Director one of each of the following per Operation and Maintenance Manual required by the entirety of these Documents.
 - 1. One printed copy of all field programming for all components in system.
 - 2. One copy of all diagnostic software with copy of field program for each unit.
 - 3. One copy of all service manuals, parts list, and internal wiring diagrams of each component of system.
 - 4. One copy of all field wiring runs location and end designation of system.

3.11 WARRANTY

- A. The entire responsibility of the system, its operation, function, testing and complete maintenance for three (3) years after final acceptance of the project by the owner, shall also be the responsibility of the manufacturer's authorized representative.

END OF SECTION 27 51 23

SECTION 27 51 25 - INTERCOM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section contains the requirements for the Intercom System. The system provides basic call with video from multiple locations to four master stations in the building. The system also has the capability as indicated on the drawing to send a closure to the access control system allowing access to be granted to an area.
- B. The system shall be an extension of the existing Aiphone IX video intercom system.

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED BY THE INTERCOM SYSTEM CONTRACTOR

- A. The Contractor shall be responsible for the interconnection of the intercom system to the Access Control System. The ISC shall verify the exact requirements with the Access Control Contractor to assure that these requirements are successfully executed.

1.3 RELATED SECTIONS

- A. Section 270500 – Communications Common Work Results
- B. Section 270524 – Technology Firestopping
- C. Section 270528 – Pathways for Communications Systems
- D. Section 271513 – Communications Copper Horizontal Cabling System
- E. Section 281300 – Access Control System

1.4 REFERENCES

- A. NFPA 70 – The National Electrical Code

1.5 SYSTEM DESCRIPTION

- A. The Intercom System shall be a new door entry system that appears in several locations. The Contractor shall thoroughly review the plans to account for all systems. These systems include, but may not be limited to, each of the main building entrances, food service delivery door and athletic entrance.

1.6 SUBMITTALS

- A. Product Data Sheets
- B. Product Data Sheets required under this Section's scope of work shall be:
 - 1. Door Entry Stations
 - 2. Master Stations

3. Power Supplies
 4. Relay Modules
- C. As-built documentation for all occurrences of the systems provided under the scope of the Specification shall be provided to the Engineer for review and approval, and upon approval of the Engineer, provided to the Owner.
- D. As-built documentation shall contain, at a minimum:
1. Locations of all the systems provided,
 2. Riser(s) with all details of the individual installations, including, but not limited to,
 - a. Device or component manufacturer and model numbers,
 - b. Specific I/O points on the devices or equipment;
 - c. Type of cable(s), and any cable ID installed;
 - d. Nature of signal being transmitted, such as VGA or IR Control;
 - e. Any other pertinent detail of the interconnection to assist in the ongoing maintenance and upkeep of the system.
 - f. Note: Where the systems provided repeat in layout, a single riser may be provided. However, any deviation of the installation, such as varying quantity of speakers, shall require a separate and unique riser for each deviation. Each riser required shall be provided with a unique title to make it easily identifiable when being referenced. Should such deviations exist, the plans indicating the location of each of the systems shall clearly indicate which riser is applicable to each individual occurrence of the system.
 3. A complete list of all equipment with Manufacturer, Model Number, Serial Number, and location of the equipment shall be compiled and turned over to the Owner representative prior to final acceptance of the project.
 4. Listing of all users serviceable parts, including, but not limited to, Manufacturer and Model number of part(s).
- E. This documentation shall be submitted to the Engineer in hard copy, bound in an organized and labeled fashion, as well as an electronic copy in pdf format.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. The components shall be as specified on the riser diagram.
- B. Basis of design shall be Aiphone IX video intercoms.

PART 3 - EXECUTION

3.1 WORK COMPLETION

- A. The Contractor shall provide a complete and functioning system, based on the designs as set forth in these construction documents. Any and all equipment, either implied or intentionally omitted from these documents, but generally accepted as being required for the completion of the installation, as represented in these construction documents, shall be provided by the Contractor at no additional

cost to the Owner.

- B. The Contractor shall provide all necessary interconnecting cable and interface devices to provide the system interfacing as described herein.
- C. All products and system configurations will be fully tested and operational prior to final payment.
- D. The Contractor shall provide complete training on the system prior to final acceptance.
- E. System Commissioning, including testing and certifications, shall be prior to final payment. All system operation or installation deficiencies shall be documented and submitted to the Owner at time of commissioning and shall be resolved prior to final training and final payment.

3.2 TRAINING

- A. Provide a minimum of eight (8) hours training on the operation of the system.
- B. Provide two (2) digital video copies of all training.

3.3 WARRANTY

- A. Warranty of the system, including parts and labor, shall be by the system supplier and manufacturer for all materials and workmanship for a period of three (3) year, or for the duration of the manufacturer's documented warranty whichever is greater. Should for some unforeseeable reason, should the installer not be able to complete the term of the warranty, the manufacturer shall bear the complete responsibility of the warranty for both parts and labor, and shall appoint a certified service organization to complete the term of the warranty. The manufacturer shall inform the Owner of this appoint in writing.
- B. The warranty period shall begin after substantial completion of all work, including Technology Bid Package systems. At which time the installer shall provide service within a 24 hour period after notice by the Owner.

END OF SECTION 27 51 25

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SECTION 27 51 75 - WIRELESS CLOCK SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. The work of this section includes a Wireless Clock System. Included in this work shall be a complete and full functional clock system with coverage throughout the new facility at all points. Provide a receiver to synchronize with the Global Positioning System satellites, an interface to synchronize to, or send synchronization information to, an IP based network time server, and a transmitter to broadcast local time synchronization information.
- B. Contractor shall provide an extension of the District's existing system: Primex Wireless.

1.2 RELATED SECTIONS

- A. Section 27 05 00 – Communications Common Work Results
- B. Section 27 05 25 – Technology Firestopping
- C. Section 27 05 28 – Pathways for Communications Systems.

1.3 DEFINITIONS

- A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

1.4 SYSTEM DESCRIPTION

- A. Clock system shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired.
- B. Time system shall be a synchronized master-satellite time system. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.
- C. Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- D. The system shall include internal clock so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
- E. The system shall incorporate fail-safe design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
- F. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

1.5 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of manufacturers latest model.
- B. Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:
 - 1. The equipment shall not cause harmful interference.
 - 2. The equipment shall accept interference that will cause adverse on equipment operation.
 - 3. Transmitter frequency shall be governed by FCC Part 90.35.
 - 4. Transmitter output power shall be governed by FCC Part 90.257 (b).
- C. The system shall be UL listed.
- D. System shall be installed in compliance with local and state authorities having jurisdiction.

1.6 SUBMITTALS

- A. Product Data:
 - 1. Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure or color card showing available colors and finishes of clocks. Note to Specifier: In accordance with FCC regulations, an application for license must be filed prior to use of the equipment. Normally, the manufacturer will have completed the filing and obtaining the license. If not, the Owner will be required to file the application with the FCC prior to use. Furnishing the license, or a copy of the application, will confirm that FCC approval has been obtained.
- B. Operating License:
 - 1. Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.
- C. Samples:
 - 1. Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
- D. Manufacturer's Instructions:
 - 1. Submit complete installation, set-up and maintenance instructions.

1.7 SUBSTITUTIONS

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days prior to bid date.
- C. Other systems requiring wiring and/or conduit between master and clocks, or which require connection of clocks to external electrical power supply will not be acceptable.

1.8 QUALITY ASSURANCE

- A. Permits: Obtain operating license for the transmitter from the FCC.
- B. Qualifications
 - 1. Manufacturer: Company specializing in manufacturing commercial time systems with a minimum of 10 continuous years of documented experience.
 - 2. Installer: Company with documented experience in the installation of commercial time systems.

1.9 DELIVERY STORAGE AND HANDLING

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in unopened containers until ready for installation. Store in building in finished, air-conditioned space.

1.10 PROJECT/SITE CONDITIONS

- A. Clocks shall not be installed until painting and other finish work in each room is complete.
- B. Coordinate installation of GPS receiver with work on the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.11 SYSTEM STARTUP

- A. At completion of installation and prior to final acceptance, start up the equipment, assure that all equipment is operating properly, and that all clocks are functioning.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Master-Satellite Time System shall have a basis of design of Primex Wireless.

2.2 SEQUENCE OF OPERATION

- A. Transmitter Operation:
 - 1. When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.
- B. Clock Operation:
 - 1. When the batteries are inserted into the clock:
 - a. Press the red button when the red second hand is at the 12:00 position. At this time the microprocessor will lock in the location of the second hand.
 - b. After the red second hand has passed over the minute hand (first second hash mark after minute hand), press and release the red button. At this time the microprocessor will lock in the location of the minute hand. The microprocessor then assumes the location of the hour hand.

- c. After the red button has been pressed twice, the microprocessor will start searching the channels. It will start at channel No. 1 and proceed one by one until it either decodes a valid signal or reaches channel No. 16. If no signal is detected the receiver will be shut off and try again later. If a signal is received, the micro processor will store the channel number, set the clock to the receive time, then for the next minute the clock will beep every time that it receives a valid time signal. If the clock is in a good signal area it will beep once a second. If the clock beeps every few seconds, the clock is in a marginal signal area. Clocks should operate in marginal signal areas, but battery life will be about 25 percent shorter.
2. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and starting with the stored channel, it will again look for a valid time signal. However, the beeper will not operate.
3. If the clock has not decoded a valid time signal for seven days, then it will go back to a double step mode. Non signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

C. Equipment

1. General
 - a. The time system shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.
 - b. Transmitter: Primex Wireless Model FM-72, or equal by Sapling or American Time and Signal, consisting of wireless transmitter with GPS receiver. Unit shall obtain current atomic time from satellite, The clock system shall transmit time continuously to all clocks in the system.
2. Transmission
 - a. Frequency Range: One watt at frequency of 72.100 to 72.400 MHz.
 - b. Transmission Range: One mile, open field.
 - c. Radio technology: Narrowband FM
 - d. Number of channels: 16
 - e. Channel bandwidth: 20 kHz maximum
 - f. Transition mode: one-way communication
 - g. Data rate: 2 KBps
 - h. Operating range: 0 degrees C. to 70 degrees C.
3. Transmitter:
 - a. Transmitter output power: +30 dBm (one watt)
 - b. Frequency deviation +/- 4 kHz
 - c. Transmitter power requirements: 120 VAC 60 Hz
 - d. Internal power requirements: 5 volts DC
 - e. Carrier frequency stability +/- 20 ppm
4. Transmitter shall have 16 selectable channels to assure interference-free reception.
5. Transmitter shall have the following switches:
 - a. Time zone adjust switches for all time zones in the world. Includes all US time zones: Eastern, Central, Mountain, Pacific, Alaska and Hawaii.
 - b. Daylight saving time bypass switch.
 - c. 12-hour or 24-hour display.
6. Transmitter housing shall be black metal case, 16-3/4 inches by 12 inches by 1-7/8 inches in size.
7. Antenna shall be 46 inches high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be > 110 dBm. Antenna polarization shall be data logic, zero to 5 volts.
8. Transmitter housing shall incorporate a display which shall include the following:
 - a. Time readout

- b. AM and PM indicator if 12 hour time display is set
 - c. Day and date readout
 - d. Indicator for daylight savings or standard time
 - e. LED which shall flash red in event of reception problem
 - f. GPS reception indicator
 9. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.
- D. Power supply:
 1. Model Number: Q11666
 2. Input: 120 volt AC 50/60 Hz, 0.4 amp.
 3. Output: 9 volt DC, 1.5 amp.
 4. TC shall select appropriate cable length for distance between GPS unit and transmitter, from the following:
 - a. GPS Receiver: Model Number Q 11722, GPS roof mounted, with 15 foot cable attached (additional cable available: 50 100 150 200 foot Primex Wireless cable).
- E. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, 3-7/8 inches by 4-3/16 inches by 2 inches, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
- F. Contractor shall provide interface to extend master clock into paging system.
- G. Clocks:
 1. Primex Wireless clocks, or equal by Sapling or American Time and Signal, 12-1/2 inch diameter or 16 inch diameter as selected, color and finish as selected from manufacturer's standard colors and finishes. Clocks shall be wall mounted, and 12-1/2 inch diameter clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black. Clocks shall be provided with red sweep second hand.
 2. Clocks shall be battery operated, and shall have 5 year battery life.
 3. Clocks shall be capable of automatically adjusting for daylight saving time. An on-off switch located on the transmitter shall disable this function if desired.
 4. Time shall be automatically updated from the transmitter 6 times per day.
 5. Clocks shall remember the time during changing of batteries.
 6. Clock lock: Tamper-proof/theft resistant hangers and slots in the backs of the clocks.
 7. Clocks shall be single and double faced as indicated on the Drawings.
 8. Provide 2 alkaline D cell batteries with each clock.
 9. Clock receivers shall be as follows:
 - a. Decode sensitivity: >-110 dBm
 - b. Receiver power: Two alkaline "D" cells
 - c. Antenna type: internal
 - d. Antenna gain: -7 dBd
 10. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
 11. Clocks:
 - a. Analog
 - 1) 12.5" Black, single sided
 - 2) 12.5" Black, Dual-Sided
 - 3) 16" Black, for all Gyms, Student Dining and Commons Areas.
 - b. Digital
 - 1) 2.5", 6-digit display, 120 VAC

12. Where wire guards are depicted on the floorplans for the protection of clocks, provide the following equipment:
 - a. Wire Guards: Provide one for each clock as follows:
 - 1) 14 by 14 inch size, for nominal 12.5 inch diameter clocks.
 - 2) 18 by 18 inch size, for 16 inch diameter clocks.
 13. Provide an analog clock with remote antenna in rooms that are shielded from radio frequencies.
- H. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that construction is complete in spaces to receive equipment and that rooms are clean, dry, and permanent air conditioning systems are operating.
- B. Verify that 120-volt electrical outlet is located within 6 feet of location of transmitter, and that outlet is operational and properly grounded.

3.2 INSTALLATION

- A. The Contractor shall review the design of the facility with the Clock manufacturer and provide all receivers, transmitters and local repeaters required to provide 100% coverage of the entire facility. These devices shall be located as recommended by the manufacturer.
- B. The GPS unit must have a clear view of the sky. If the GPS unit is mounted on the roof, it must be located on a suitable bracket, well above the level of standing or incidental water. If the GPS unit is mounted at a window, it must be located away from low-E glass. A. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements. Provide a platform for installation of transmitter, a minimum of 2 to 3 feet above the floor. The preferred transmitter location for best transmission coverage is on the top floor of the building.
- C. Transmitter:
 1. Locate transmitter where indicated, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.
 2. Attach receiver to transmitter using coaxial cable.
 3. Connect antenna to transmitter, using care not to strip threads.
 4. Connect power supply to the transmitter.
 5. Set the channel number on the display to correspond to the FCC license.
 6. Plug power supply into electrical outlet.
 7. Clocks: Perform the following operations with each clock:
 - a. Install D cell batteries.
 - b. Set clock to correct time in accordance with manufacturer's instructions.
 - c. Observe clock until valid signals are received and clock adjusts itself to correct time.
 - d. Install the clock on the wall in the indicated location, plumb, level, and tight against wall.
 - e. Attach using Clock-Lock hanging method and suitable fasteners as approved by clock manufacturer.

f. Delete the following if wire guards are not required.

1) Wire Guards: Secure to wall, using approved theft-resistant fasteners.

3.3 ADJUSTING

A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.4 CLEANING

A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.5 DEMONSTRATION

A. Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

3.6 PROTECTION

A. Protect finished installation until final acceptance of the project.

B. Provide **three (3)** year warranty on all parts and materials from date of Owner acceptance.

END OF SECTION 27 51 75

SECTION 28 13 00 - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. The system shall be an extension of the Owner's existing system: PremiSys, by Identocard, Access Control System.
- B. Provide one enterprise system administrated via one or more networked PC on the District's network.
- C. Provide accessibility by means of Apple or Android powered smartphone, either via cellular connection or via the District's network.
- D. The Contractor shall provide a Card Access System (CAS) that shall provide all personnel recognition, access, monitoring and control. The system shall provide standard card access functionality allowing electronic control of the doors indicated, as well as integration to the Video Surveillance System, Intrusion Detection and the entry Intercom Systems. In addition to the required hardware to provide these functions, the Contractor shall provide as may be required, individual servers or building controllers, reporting to a centralized server that shall provide the required access to administer the system, as well as a minimum of eight thick remote client software licenses to be installed and configured as directed by the Owner.
- E. Contractor shall provide all licenses needed for a 100% fully functional system.
- F. The system shall provide local and remote operational control of all access points and alarm sensors.

1.2 SECTION INCLUDES

- A. Servers and Software
- B. Local Control Panels
- C. Credential Readers
- D. Credentials
- E. Credential Printer/Encoder
- F. Request To Exit Pushbuttons
- G. Remote Release Pushbuttons
- H. Request to Exit Motion Detectors
- I. Door Position Switches
- J. Power Supplies
- K. Driver's License Scanner

L. Visitor Management System

1.3 PRODUCTS INSTALLED BUT NOT SUPPLIED BY THE CONTRACTOR

- A. The Contractor shall provide all cabling, system I/O, programming, and related hardware to control electric strike hardware or other door control hardware provided by the door hardware supplier. Coordinate exact requirements with door hardware supplier.

1.4 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 27 05 00 – Communications Common Work Results
- B. Section 27 05 24 – Firestopping
- C. Section 27 05 26 – Technology Grounding System
- D. Section 27 05 28 – Pathways for Communications Systems
- E. Division 1 – General Requirements

1.5 DESCRIPTION

- A. The Contractor shall provide a completely functional card access system, for the purposes of controlling and monitoring of all indicated potential means of entry, or other point of alarm. Items specified but not drawn, or drawn but not specified shall be considered to be within the scope of the Documents. The Documents show the intent of the system, and the Contractor shall provide all required devices, cabling and equipment to fulfill the intent of the Documents
- B. The system shall provide controlled access into areas and through doors as indicated on the Drawings, utilizing proximity sensors, keypads, mag locks, electric strikes, door contacts and push buttons.
- C. The system shall be capable of monitoring the exterior doors equipped with door contacts. The Contractor shall provide client software in the high school office and that shall be loaded onto school district provided PC's that shall annunciate the status of the doors, i.e. indicate if these doors are open, based on the status of the door contacts.
- D. The Contractor shall provide a dedicated credential reader in the new school to be utilized for user enrollment.
- E. The system shall initiate communication to the Video Surveillance System to trigger events related to both authorized and unauthorized entry into any given door that is either monitored or controlled.
- F. The system shall integrate the viewing of triggered events on a common graphic user interface allowing for the visual review of the location, as well as the logged event of the card access system.
- G. The system shall provide remote release of select doors as indicated on the plans.
- H. The system shall be wired, where the contacts are available in the door hardware, to provide latch monitoring functionality in addition to the door position monitoring.
- I. Where an exterior or other door is monitored by both access control and intrusion detection, the Contractor shall provide two pole door contacts to facilitate individual monitoring by each system

while minimizing modifications to the door framing.

1.6 GENERAL CONDITIONS

A. After-Sales Support

1. The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to maintain/repair the system after system acceptance.

B. Quality Assurance

1. All equipment, systems, and materials furnished and installed shall be new and installed in accordance with the applicable standards of:
 - a. National codes: NEC, NFPA, UBC
 - b. Approvals and listings: UL 1076 listed
 - c. Security Industry Association (SIA)
 - d. Local Authorities Having Jurisdiction

C. Warranty

1. All components, parts, and assemblies supplied by the Manufacturer and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least (3) three years (parts and labor), commencing upon date of substantial work. A qualified factory-trained service representative shall provide warranty service.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF SYSTEM

A. Provide an extension of the District's existing PremiSys, by Identocard, Access Control System

B. The system hardware and software shall be a commercial off the shelf product of a reputable manufacturer with a history of providing systems designed for this purposes for a minimum of at least 5 years.

C. The system shall be UL listed and approved for the application intended and shall be compliant with all standards and regulations that may apply. These listing and approvals shall include, but not be limited to, FCC, CE, UL 1950, UL 294, and UL 1076. The latter UL 1076 will be applied only to the overall system, including the host when available.

D. The Local Control Panels (LCP) shall be extensible to seamlessly interface to a dedicated Web based Central Card Administration System (CCAS) or host computer. The CCAS shall allow a central point of administration and reporting of all personnel records and activities, and shall be accessible by means of both thick clients in a client/server environment.

E. Lockdown

1. A Lockdown shall be initiated in the following ways:
 - a. Physical pushbuttons located in the building
 - b. Software initiated over main PC based administrative console
 - c. Utilizing the Access Control System's mobile based software
2. This Contractor shall program and coordinate the Lockdown's sequence of events as directed by the District. At a minimum, the Contractor shall provide the following functionality:
 - a. The Access Control system shall send a signal to the Fire Alarm system that a Lockdown has occurred
 - b. All magnetically held open doors will release, latch and lock

- c. All access-controlled doors will lock.
 - d. All video surveillance cameras will continuously record at 5 f/s for the entire length of the Lockdown
 - e. The Access Control system shall send a signal to the Paging System.
 - 1) Paging System shall play a pre-recorded message. This message shall be created as directed by the District.
 - f. The Access Control system shall send an email to recipients as directed by the District.
3. This Contractor shall provide and verify how the District will lift a Lockdown.

2.2 CCAS HARDWARE AND SOFTWARE SYSTEM REQUIREMENTS

A. General

1. The Web based CCAS shall operate on a dedicated server system or host computer. This dedicated server shall run network and Internet services for industry standard web browsers to use in order to administer personnel records. For reporting purposes a browser-accessible reporting package shall be used. Dynamic on-line help shall be available within the software with step-by-step instructions available for common administration tasks.
2. A copy of all personnel records from the individual LCP's shall be stored in the CCAS and shall be available to all authorized operators. All hardware components/modules shall be commercial off-the-shelf products offered by recognized industry manufacturers. Systems utilizing proprietary hardware shall not be acceptable.
3. The client Web browser PC shall be 100% IBM compatible PC running Microsoft IE and network enabled. No proprietary or advanced computer hardware, i.e. high end video graphics cards, etc. shall be necessary in order to retrieve and/or edit personnel records.
4. The system shall support multiple operator permission levels.

B. Minimum Server/Host Specifications

1. Computer hardware defined within shall be used as a guideline and minimum level of expectation. Contractor shall verify optimal hardware configurations with the system manufacturers and provide system as recommended by the manufacturer that provide the best performance for the project specific system being provided, having capacity sufficient for 100% of the day 1 configuration with a growth potential of 50% including, but not limited to storage capacity for transactions and records, as well as throughput for an increase in overall system size and complexity.
2. The ACSDB CPU shall be a 100% Intel x64 based architecture running either Microsoft Windows Server 2012 R2 or greater (version as recommended by the ACSDB manufacturer) or Linux. As referenced above, these component requirements shall only act as a minimum guideline. Provide either the manufacturer recommended optimum configuration or that which is indicated below, whichever is greater.
 - a. Processor: Xeon Quad Core, 2.4 Ghz
 - b. Ram: 16 Gb RAM, 2133 MHz minimum
 - c. Hard Drive: RAID 5
 - 1) OS Drive: Sized as recommended by ACS manufacturer based on selected OS
 - 2) Data Storage: Sized as recommended by ACS manufacturer based on Quantity of portals, size and complexity of system with a 50% growth factor.
 - d. Optical Drive: 8x Recordable DVD drive
 - e. Workstation Monitor: 21" SVGA monitor (1920 x 1080 resolution @ 65,536 colors)
 - f. I/O: (4) USB
 - g. Mouse: USB mouse
 - h. Keyboard: Standard US 101 keyboard, USB
 - i. Network Adapter: 1000 Mbps Ethernet Adapter
 - j. Display Adapter: HDMI

3. Acceptable manufacturer:
 - a. Dell
 - b. HP
 - c. Lenovo
 - d. As supplied and configured by the CCAS manufacturer

C. Software requirements

1. In addition to the required hardware specified elsewhere, the following software components shall be used in the CCAS.
 - a. Provide PremiSys, by Identocard, Server Pro version on a dedicated PC.
2. Contractor shall provide all licenses to integrate into Owner's existing ExacqVision Video Surveillance servers.

2.3 SYSTEM HARDWARE

A. The System shall consist of Local Control Panels, peripheral I/O Cards, Door Position Switches (Door Contacts), Credential Readers and related hardware and cabling.

B. The Contractor shall interface the Fire Alarm System with the Access Control System. Contractor shall coordinate exact requirements with Fire Alarm System Contractor.

C. Local Control Panels

1. The system shall utilize Local Control Panels that,
 - a. have processing capabilities so as to remain completely operational in an offline mode should the communications link become non-functional,
 - b. have a battery backup to provide a minimum of four hours of continuous operation during power outages,
 - c. have the capability to interface standard Wiegand devices, as well as provide I/O to various serial protocols, including but not limited to RS-485, RS-422 and RS-232,
 - d. have as a part of their standard package the ability to communicate with servers and other local controllers via an Ethernet based TCP/IP protocol,
 - e. and, have peripheral I/O panels that provide additional digital I/O both logic level and form-C contacts.
 - f. Acceptable Manufacturers shall be:
 - 1) PremiSys, by Identocard
2. The Contractor shall provide sufficient cabinets, card and related hardware to control all doors, door contacts and other related devices indicated on the drawings, plus spare capacity of 25% per Telecommunications Room (TR). This spare capacity shall be distributed throughout the system control panels on a TR by TR basis, i.e. each TR shall contain the available spare capacity as defined above.
3. The Contractor shall provide the appropriate cards required to fill each LCP to 100% utilization, and shall provide the required cards to be completely capable of speaking both the protocol of the devices cabled to the port, and to allow the LCP to communicate over a standard Ethernet network utilizing standard TCP/IP protocol.
4. The Contractor shall include all power supplies, batteries and other peripheral devices required to provide a fully functional system as described herein, and indicated on the Drawings.
5. Contractor shall provide a NIC card and dedicated UTP cabling for each panel.

D. Credential Readers and Credentials

1. Credential Reader
 - a. The Credential Reader shall be legacy 125kHz based proximity sensor.

- 1) The sensor shall read encoded data from the fob and/or transponder and transmit the data back to the host panel, giving an audible and visual indication of a properly read card.
- 2) The sensor shall be no larger than 5.0" x 5.0" x 1.0" (12.7 X 12.7 X 2.54 cm).
- 3) The sensor shall have a typical read range of 5.5" to 8" (14 - 20 cm), when used with a HID Corporation ProxCard II™ proximity card.
- 4) The sensor shall be provided with an internal tamper switch that will indicate an alarm condition if an unauthorized attempt is made to disassemble the unit.
- 5) The sensor shall be a single unit with properly sized mounting holes that allow it to be attached directly to a single gang electrical box.
- 6) The sensor shall be sealed to a NEMA rating of 4X, and all internal electronics will have conformal coating to provide a high degree of environmental protection.
- 7) The sensor shall be listed under UL 294 as an access control system accessory, and shall be FCC and DTI certified.
- 8) The sensor shall have separate terminal control points for the green LED, the red LED, and the audible indicator.
- 9) The sensor shall have a hold line that will buffer a card read until the panel has asserted that the information can be sent up line.
- 10) The sensor shall have a re-present mode in which the card must be taken from the reader field for one second before being read again.
- 11) The sensor shall be fully weatherized, and shall have an operating temperature of -22 to 150 degrees Fahrenheit (-30 to 65 degrees Celsius), and shall have an operating humidity of 5-95% noncondensing.
- 12) The sensor shall have a lifetime warranty.
- 13) The sensor shall be made from polycarbonate material, and shall be charcoal gray or beige.
- 14) The sensor shall transmit at a 125 kHz frequency.
- 15) The cable requirements of the sensor shall be a minimum five- (5) conductor, 22 AWG, stranded cable with overall shield (for a Wiegand protocol interface). A six- (6) conductor cable is required when controlling the red and green LED individually. A seven- (7) conductor cable is required when both the red and green LED's are controlled by the Host. A 22 AWG twisted pair, shielded, stranded cable is required for use of the tamper switch.
- 16) The sensor shall have the following configuration options which are user selectable by dip switch settings:
 - a) Sensor beeps and flashes green on a card read, LED normally red, single line control of LED.
 - b) Sensor flashes green on a card read LED normally red, single line control of LED.
 - c) Sensor beeps on a card read, LED normally red, single line control of LED.
 - d) Sensor and LED are controlled by host only, LED normally red, single line control of LED.
 - e) Sensor beeps and flashes green on a card read, LED normally off, red and green LED's controlled individually.
 - f) Sensor flashes green on a card read, LED normally off, red and green LED's controlled individually.
 - g) Sensor beeps on a card read, LED normally off, red and green LED's controlled individually.
 - h) Sensor and LED are controlled by host only, LED normally off, red and green LED controlled individually.

- 17) The sensor shall communicate in a Wiegand protocol interface, and be compatible with all standard access control systems.
 - 18) The sensor shall also be available in optional RS232 and RS422 serial interfaces.
 - 19) The voltage requirements of the sensor shall be 10-28.5 VDC.
 - 20) The current requirements of the sensor shall be:

a)	Current (DC)	Average		Peak
	(1)	Wiegand	100 mA	160 mA
	(2)	Serial	100 mA	160 mA
 - 21) Acceptable Manufacturer and Model
 - a) HID – ProxPro
 - b) Equal by PremiSys, by Identocard
2. Mullion Style Credential Reader
- a. The Credential Reader shall be legacy 125kHz based proximity sensor.
 - 1) The sensor shall read the encoded data from the access card and/or transponder and transmit the data back to the host panel, giving an audible and visual indication of a properly read card.
 - 2) The sensor shall be no larger than 6.0" x 1.7" x 0.75" (15.2 X 4.3 X 1.91 cm).
 - 3) The sensor shall have a typical read range of 4" to 5.5" (10 - 14 cm), when used with a HID Corporation ProxCard II™ proximity card. (See attached chart for read ranges with other HID Corporation proximity cards and transponders.)
 - 4) The sensor shall be a single piece unit, narrow enough to be mounted onto a 1.75" (4.45 cm) metal doorframe or mullion.
 - 5) The sensor shall be listed under UL 294 as an access control system unit accessory, and shall be FCC and DTI certified.
 - 6) The sensor shall have separate terminal control points for the green LED, the red LED, and the audible indicator.
 - 7) The sensor shall have a hold line that will buffer a card read until the panel has asserted that the information can be sent up line.
 - 8) The sensor shall have a re-present mode in which the card must be taken from the reader field before being read again. This feature is required to eliminate multiple reads from a single card presentation.
 - 9) The sensor shall have a built in anti-passback delay of one second.
 - 10) The sensor shall be fully weatherized, and shall have an operating temperature of -22 to 150 degrees Fahrenheit (-30 to 65 degrees Celsius), and an operating humidity of 5-95% noncondensing.
 - 11) The sensor shall have a lifetime warranty.
 - 12) The sensor shall be made from polycarbonate material, and shall be charcoal gray or beige.
 - 13) The sensor shall transmit at a 125 kHz frequency.
 - 14) The cable requirements of the card reader shall be a minimum five- (5) conductor, 22 AWG, stranded cable with overall shield (for a Wiegand protocol interface). A six- (6) conductor cable is required when controlling the red and green LED individually. A seven- (7) conductor cable is required when both the red and green LED's are controlled by the Host. A 22 AWG twisted pair, shielded, stranded cable is required for use of the tamper switch. The card reader shall be provided with a 9-wire pigtail connector.
 - 15) The sensor shall have the following reader configuration options:
 - a) Sensor beeps and flashes green on a card read, LED normally red, single line control of LED.
 - b) Sensor flashes green on a card read, LED normally red, single line control of LED.
 - c) Sensor beeps on a card read, LED normally red, single line control of LED.

- d) Sensor and LED are controlled by host only, LED normally red, single line control of LED.
- e) Sensor beeps and flashes green on a card read, LED normally off, red and green LED's controlled individually.
- f) Sensor flashes green on a card read, LED normally off, red and green LED's controlled individually.
- g) Sensor beeps on a card read, LED normally off, red and green LED's controlled individually.
- h) Beeper and LED are controlled by host only, LED normally off, red and green LED controlled individually.
- 16) The sensor shall communicate in a Wiegand protocol interface, and be compatible with all standard access control systems.
- 17) The voltage requirements of the card reader shall be 4.75 to 16 VDC.
- 18) The current requirements of the card reader shall be:
 - a) Current (DC)
 - b) Voltage Average Peak
 - c) 5 VDC 50 mA 70 mA
 - d) 12 VDC 60 mA 140 mA
- 19) Acceptable Manufacturer and Model
 - a) HID – MiniProx
 - b) Equals by PremiSys, by Identocard,

E. Request To Exit Pushbuttons

- 1. All button stations shall be mounted on a standard size single gang or narrow plate.
- 2. All buttons shall have a square 2" exit button, mounted on a stainless steel single gang plate.
- 3. All buttons shall provide a spring loaded momentary closure.
- 4. All button stations shall be capable of operating at 12 or 24 VDC, and provide a 30 second lock release signal.
- 5. All button stations shall be UL listed.
- 6. All button stations shall have a lifetime warranty.
- 7. Acceptable Manufacturer and model:
 - a. Securitron EEB2
 - b. Or equivalent product by Safety Technology International or Security Door Controls
 - c. Provide cabling as required by manufacturer

F. Door Contacts

- 1. Contacts shall be recessed, round, magnetic contacts that shall be .75" and shall be manufactured by Ademco, GE, or Sentrol.
- 2. Contacts shall be DPDT

G. Request to Exit Motion Sensors

- 1. The sensor shall have a pick up pattern specifically designed to limit the coverage tight to the exit way.
- 2. The sensor shall be capable of operating in a range from 12 to 28 volts DC.
- 3. The sensor shall contain a form C relay integral to the unit.
- 4. The sensor shall have a lifetime warranty.
- 5. Acceptable Manufacturer and model shall be:
 - a. Securitron XMS
 - b. Or equivalent product by GE or Bosch
 - c. Provide cabling as required by manufacturer

H. Power Supply

1. The power supply shall utilize a nominal 120VAC input.
2. The power supply shall provide switch selectable fail safe/fail secure for each of 8 fuse protected outputs.
3. Provide power supplies for all door hardware specified elsewhere.
4. All power supplies shall be provided in the nearest Telecommunication Rooms to the door hardware that it is serving.
5. The power supply shall provide an interface to the fire alarm system to react to fire alarm triggers.
6. The power supply shall provide internal LED indicators for AC input, DC output and fire alarm triggered.
7. The power supply shall provide a sealed lead acid battery and an integral battery charger.
8. The power supply shall have a supervisory circuit for battery present and battery fail.
9. Acceptable Manufacturer and Model:
 - a. Altronix AL400ULACM
 - b. Equal by Honeywell or Securitron

I. Door Hardware Power Supplies

1. For all controlled doors, the Contractor shall remote all electrified door hardware power supplies within the MTR or TR's. Contractor shall provide all power supplies and associated low voltage powered cabling as directed by door hardware manufacturers.
2. Refer to Architectural Door Hardware Schedule and Specifications for additional information.

J. Driver License Scanner System

1. Provide a scanner and associated software that shall scan a driver's license and/or state issued ID and immediately check against a national database and a user-created Deny List.
2. Scanner and software shall be compatible with the Visitor Management system and Access Control System
3. Provide (1) Scanner system at each of the (3) Reception Desks.

K. Visitor Management System

1. Provide (1) Visitor Management system at each of the (3) Reception Desks.
2. Acceptable Manufacturer and Model:
 - a. HID EasyLobby.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall provide all hardware and cabling to install all devices and equipment as indicated on the plan, and to suite location and environment. These devices shall include, but not be limited to, Z-brackets, to provide proper installation of devices as required by the field conditions.
- B. Cabling shall be installed in metallic conduits in exterior or unsecure areas or run open cable where applicable. Cabling shall be continuous from device to termination point without splices. Termination of cables shall be at equipment locations only. Install cabling without sharp bends and terminate only with approved connectors. (Underground may be installed in PVC conduit. Direct burial cable is not acceptable.)
- C. The Manufacturer's installation procedures shall be considered part of these specifications, though not explicitly indicated here, and shall be adhered to during the entirety of the project.

- D. Contractor is responsible for mounting all exterior mounting brackets and devices (either pole mounted or mounted to the building).
- E. All outside components, i.e. power supply, surge suppressers, receiver drivers, shall be mounted in weatherproof boxes (NEMA 3R) with stainless steel or galvanized hardware.
- F. Special care in cable installation shall be exercised to avoid grounds due to careless termination or damage to the jacket over the shield. Take special care to ensure that random contact of shield of adjacent cables does not occur in consoles and at junction boxes. Provide a minimum of one layer Scotch #33 electrical tape or equivalent.
- G. Exterior units shall be protected from accidental contact and vandalism. Provide all required mounting hardware.
- H. All low voltage cable shall be isolated from all line voltage equipment. Contractor shall coordinate with Contractor and the EC to separate low voltage cables from line voltage wiring conductors.
- I. All installations shall be installed in a professional and workman like manner.
- J. Data collection panels and other related hardware shall be mounted as indicated on the Drawings. Contractor shall verify that all equipment is mounted within manufacturer's recommended distances to prevent unwanted voltage drops, or other abhorrent behavior.
- K. All cables (coax, data, fiber and power circuits) shall be identified with proper tagging and labels as indicated elsewhere in these specifications.
- L. All rack mounted units shall be spaced at minimum of 1 ¾-inch apart for ventilation purposes as recommended by manufacturer.
- M. Coordinate for installation of all non-Controlled Access connections to the weatherproof equipment enclosures, switchers, monitors, and other equipment specified for use in this section. These connectors include grounding, coordination, and installation of 120 VAC power.
- N. Refer to the Drawings for equipment quantities, locations, and installation details.
- O. Contractor shall provide record drawings of complete system installation. The Contractor shall forward hard copies to the Engineer for the inclusion of these Record Drawings.
- P. The Contractor shall determine the exact nature of the environment for the installation of all environmentally sensitive pieces of equipment, and substitute materials and devices consistent to the environment to which they are to be installed. Where devices being substituted are not already defined within these specifications, the Contractor shall submit the necessary cut sheets and product data for the Engineer to provide the necessary approvals prior to installation and rough-in. Any substitution required due to environmental, or field conditions shall be made at no additional cost to the Owner.

3.2 TRAINING AND INSTRUCTION

- A. Operator training shall consist of (40) hours of classroom instruction conducted on-site by a factory trained professional instructor. Training conducted by installers, technicians, or project managers is unacceptable. Provide an additional (2) hours of individual hands-on training.
- B. Training materials shall consist of the following:

1. Formal course outline and agenda
2. Operator training student guide for each student.
3. Hands-on practice with on-line equipment.

C. The training course shall be a minimum of two contiguous business days.

D. The Contractor shall video record the training, transfer it to a standard DVD formatted disk, and provide (2) digital videos to the Owner at no additional cost to the Owner.

E. Provide all materials required for the Operations and Maintenance Manuals.

3.3 MOUNTING HEIGHTS AND LOCATIONS

A. The equipment height shall be as noted on the drawings. Care must be taken to ensure that mounting heights set forth by the Americans with Disability Act (A.D.A.) for said items is met.

B. All cabinets and equipment installed in MCC's or TR's shall be installed per the room elevations indicated on the Drawings. Failure to comply with the room layouts shall cause the Contractor to remove and reinstall the devices and equipment in the proper location. Should a conflict arise due to unforeseen conditions, the Contractor shall contact the Engineer immediately for a resolution.

C. All door contacts shall be hidden within the door frames. Should this installation method be unavailable, the door contact must be surface mounted on the secure side of the door.

3.4 GUARANTEE

A. Contractor shall provide a three (3) year warranty on installation of the entirety of the CAS. Any defective material shall be replaced at no expense to the Owner (including labor).

B. The Contractor's guarantee shall cover all costs associated with the troubleshooting, repair, and replacement of defective work, including costs of labor, transportation, lodging, materials, and equipment.

C. The Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification, or repair by the Owner, or acts of God.

3.5 COMMISSIONING

A. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features required for project. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

B. Contractor shall submit a request for the Acceptance test in writing to the Owner's Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.

C. During Acceptance test, Contractor shall demonstrate all equipment and system features to Owner. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by the Owner, Architect or Engineer.

D. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. Owner's Project Manager will prepare a list of any such deficiencies

observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to Owner's Project Manager for another Acceptance Test.

- E. At the conclusion of the Acceptance Test and all Work being found acceptable and in compliance with the Project Drawings and Specifications, Owner's Project Manager will issue a letter of Acceptance to Contractor.

3.6 SUBMITTALS

- A. Submittals shall include bound brochures with data sheets for all equipment specified and installation drawings. Drawings shall indicate exact wiring requirements and shall include equipment locations shown on floor plans (1/16" scale, minimum). These drawings shall be dedicated solely to indicate the CA system and related wiring.

END OF SECTION 28 13 00

SECTION 28 23 00 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. The Surveillance System shall utilize IP-based fixed focus cameras to monitor the internal and external areas of the facility. The activity shall be recorded onto network video recorders (NVR)s which will be connected into the Owner's network. Additionally, the video shall be available on the network for the Owner to access and utilize. Viewing and/or control shall occur by means of a software client loaded onto assigned PC's. Viewing only shall be capable by means of a web based interface, and/or by means of smartphones and tablets utilizing both Apple iOS and/or Android operating systems.
- B. The system shall integrate into the Access Control, Intrusion Detection and entry Intercom Systems.
- C. The system shall be compatible with the Owner's existing PremiSys, by Identocard, Access Control System.
- D. The system shall be an extension of the District's exacqVision system.

1.2 SECTION INCLUDES

- A. Cameras
- B. Network Video Recorder Software
- C. Network Video Recorder Server
- D. KVM and monitor
- E. UPS

1.3 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Section 27 05 00 – Communications Common Work Results
- C. Section 27 05 24 – Firestopping
- D. Section 27 05 26 – Technology Grounding System
- E. Section 27 05 28 – Pathways for Communications Systems
- F. Section 28 13 00 – Access Control System
- G. Section 28 15 00 – Intrusion Detection System

1.4 DESCRIPTION

- A. The Contractor shall furnish and install all labor, equipment, accessories and materials required for the installation of a comprehensive Video Surveillance System in strict compliance with these specifications and as shown on all applicable contract drawings.
- B. Any material and/or equipment necessary for the proper operation of the system not specified or described herein shall be deemed part of this specification.
- C. The requirements of the conditions of the Contract titled “Supplementary Conditions” and “General Requirements” shall apply to the work as specified in this section. The complete installation shall conform to the requirements set forth by the NEC, all State and Local Building Codes, as required by the “Authority Having Jurisdiction” and the requirements of the Owner.
- D. The equipment vendor shall provide the services of a Factory Trained Technician to supervise and make final system adjustments. This Technician, in the presence of the Owner’s representative shall test the system in its entirety.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF SYSTEM

- A. The system shall be able to integrate with the District’s existing PremiSys, by Identocard, Access Control system.
- B. The system shall be a complete IP based video surveillance system that shall utilize the Owner’s network as the method of transport to a video surveillance server that shall record and retain the video and provide an export capability to transfer files that the Owner wishes to record to an optical media.
- C. Indoor, Fixed Focus Cameras
 - 1. The Camera shall utilize Internet Protocol as the transport for the video signaling.
 - 2. The Camera shall have the following certifications and approvals:
 - a. Safety: EN 60950 (CE), UL 60950-1, CAN/CSA E 60950-1
 - b. Immunity: EN 55024 IT equipment (CE)
 - c. Emission: EN 55022 Class B (CE), EN 62000-3-2 (CE), EN 61000-3-3 (CE), FCC CFR 47 Part 15, Class B
 - 3. The Camera shall meet or exceed the following performance requirements and criteria:
 - a. Image Sensor: 1/3” progressive scan CMOS
 - b. Lens: Varifocal 3.0 – 10.5 mm/F1.4 minimum
 - c. Horizontal Angle of View: 92° - 34°
 - d. Sensitivity: 0.03 lux maximum lower threshold
 - e. Compression: MJPEG, H.264
 - f. Resolution: 1920 x 1080 (4.0 Megapixel, minimum)
 - g. IR Illumination: Yes
 - h. Analytics: Motion Detection
 - i. Network: IPv4/IPv6, QoS
 - j. PoE: 802.3af/at
 - k. Vandal Resistant: Yes, IP52
 - 4. Acceptable Manufacturers and Models shall be
 - a. Axis M3086-V
 - b. Equivalent Products by Samsung (Hanwha) or Vivotek

5. Provide enclosures and appropriate mounting bracket for each camera provided based on the location and environment of the installation location.
- D. Indoor, 360 degree Cameras
1. The Camera shall utilize Internet Protocol as the transport for the video signaling.
 2. The Camera shall have the following certifications and approvals:
 - a. Safety: EN 60950 (CE), UL 60950-1, CAN/CSA E 60950-1
 - b. Immunity: EN 55024 IT equipment (CE)
 - c. Emission: EN 55022 Class B (CE), EN 62000-3-2 (CE), EN 61000-3-3 (CE), FCC CFR 47 Part 15, Class B
 3. The Camera shall meet or exceed the following performance requirements and criteria:
 - a. Image Sensor: 4 x 1/2.8" progressive scan CMOS
 - b. Lens: Varifocal 3.0 – 6.0 mm
 - c. Horizontal Angle of View: 96° - 49°
 - d. Sensitivity: 0.17 lux maximum lower threshold
 - e. Compression: MJPEG, H.264
 - f. Resolution: 4 x 1920 x 1080 (6.0 Megapixel, minimum)
 - g. IR Illumination: Yes
 - h. Analytics: Motion Detection
 - i. Network: IPv4/IPv6, QoS
 - j. PoE: 802.3at
 - k. Vandal Resistant: Yes, IP52
 4. Acceptable Manufacturers and Models shall be
 - a. Axis M3067-P
 - b. Equivalent Products by Samsung (Hanwha) or Vivotek
 5. Provide enclosures and appropriate mounting bracket for each camera provided based on the location and environment of the installation location.
- E. Outdoor, 180 Cameras
1. Acceptable Manufacturers and Models shall be
 - a. Axis P3807-PVE
 - b. Equivalent Products by Samsung (Hanwha) or Vivotek
 2. Provide enclosures and appropriate mounting bracket for each camera provided based on the location and environment of the installation location
- F. Outdoor, 360 Cameras
1. The Camera shall utilize Internet Protocol as the transport for the video signaling.
 2. The Camera shall have the following certifications and approvals:
 - a. Safety: EN 60950 (CE)
UL 60950-1
CAN/CSA E 60950-1
 - b. Immunity: EN 55024 IT equipment (CE)
 - c. Emission: EN 55022 Class B (CE)
EN 62000-3-2 (CE)
EN 61000-3-3 (CE)
FCC CFR 47 Part 15, Class B
 3. The Camera shall meet or exceed the following performance requirements and criteria:
 - a. Image Sensor: 4x1/2.8" progressive scan CMOS
 - b. Lens: Varifocal 3 – 6 mm/F1.8-2.6 minimum
 - c. Horizontal Angle of View: 96° - 49°

- d. Day/night: Automatic
- e. Sensitivity: 0.03 lux maximum lower threshold
- f. Compression: MJPEG, H.264
- g. Resolution: 4x1920 x 1080 (8.0 Megapixel, minimum)
- h. Frame Rate (Color): 25/ 30 fps
- i. Analytics: Motion Detection
- j. Network: IPv4/IPv6, QoS
- k. PoE: 802.3af
- l. Vandal Resistant: Yes
- m. WDR: Yes
- n. IR: Yes
- o. Digital PTZ: Yes
- 4. Acceptable Manufacturers and Models shall be
 - a. Axis P3727-PLE
 - b. Equivalent Products by Samsung (Hanwha) or Vivotek
- 5. Provide enclosures and appropriate mounting bracket for each camera provided based on the location and environment of the installation location

G. Network Video Recording Software (VMS)

- 1. The VMS shall be compatible with both Windows and Linux operating systems.
- 2. The VMS shall be compatible with Owner's existing PremiSys, by Identicard, Access Control System
- 3. The VMS shall provide free client software capable of operating on Windows, Linux or Mac
- 4. The VMS shall support the following browsers:
 - a. Internet Explorer
 - b. Google Chrome
 - c. Apple Safari
 - d. Mozilla Firefox
- 5. The VMS shall support a minimum of 64 cameras per server with virtually unlimited camera quantities when servers are clustered into an enterprise solution.
- 6. The VMS client shall support of minimum of 512 server connections per client on a thick client and 16 servers per client on a web client.
- 7. The VMS shall provide the following operational features:
 - a. Bandwidth Throttling
 - b. Pre-Post Alarm Recording
 - c. Fish-Eye/Panoramic Lens Support
 - d. iSCSI Support
 - e. Time-Lapse Recording
 - f. Client Joystick Configuration
 - g. Soft Triggers
 - h. Audit Trails
 - i. Custom User Groups
 - j. 3rd Party Integrations
- 8. The VMS shall provide the following live view features:
 - a. PTZ Control and Presets
 - b. Digital PTZ Control and Presets
 - c. Multi-Monitor Support
 - d. Video Wall Support
 - e. Video Aspect Ratios of both 16:9 and 4:3
 - f. Event Linking

- g. Event Driven Video Switching
- h. Time Based Video Switching
- i. Camera Groups
- j. Event Notifications
- k. Facility Mapping
- 9. The VMS shall provide the following search, playback, export and archive capabilities:
 - a. Multi-camera playback
 - b. Simultaneous Video Export for a minimum of 16 channels
 - c. Graphical Timeline Search
 - d. Thumbnail Search
 - e. Event Search
 - f. Background Quick Export
- 10. The VMS shall support the recording, viewing, archiving and configuring of at least the following camera manufacturers:
 - a. Axis
 - b. Samsung (Hanwha)
 - c. Vivotek
- 11. The VMS shall support MJPEG and H.264 video compression formats at a minimum.
- 12. The VMS shall support unlimited number of configurable camera groups.
- 13. The VMS shall support maintenance free, transparent archiving to network or local drives. Archiving shall be configurable on a per camera basis to multiple drive locations.
- 14. The VMS shall support multiple instances per day, with no down-time during transfer of video to archiving.
- 15. The VMS shall support two-way audio from camera's microphone inputs to video client, and from client to camera's speaker output.
- 16. The VMS shall support multiple-channel audio recording.
- 17. The VMS shall provide multiple format video export, including, but not limited to still image JPEG, audio included AVI with preamble displaying all event details and user comments, and multi-camera, audio included secure video database for court evidence.
- 18. The VMS shall support multiple networks for increased security and bandwidth management.
- 19. The VMS shall include open API's and any required software and programming required for integration with physical security systems to provide a unified and singular user interface.
- 20. The VMS shall support access for PDA's and cellphones with proper authentication.
- 21. The VMS shall provide the capability to configure, view and review cameras from multiple networked recorders at multiple sites on a single interface simultaneously programmed through a process of drag and drop selection, as well as archive to an optical or solid state recording device from any recorder to a local workstation.
- 22. Acceptable Manufacturer and Product shall be:
 - a. An extension of the District's ExacqVision system
 - b. Provide any/all licensing for all cameras indicated.
 - c. Provide licensed hard clients for 10 users.
- H. Network Video Recorder Hardware (NVR)
 - 1. The NVR shall be a rack mounted unit capable of being installed in an EIA standard 19" rack without the use of custom mounting hardware with the exception of commercial, off the shelf, rack mount hardware from the NVR server manufacturer.
 - 2. Each NVR shall be a video optimized NVR server.
 - 3. The NVR hardware shall operate on either the Microsoft Windows 7 or Linux operating systems.

4. Each NVR shall be capable of simultaneously recording, displaying and playing back digitized video from IP cameras and analog cameras through the use of a video encoder. IP Server models shall be capable of being licensed to add IP cameras in increments from one (1) to 64 camera licenses.
5. The NVR shall support recording resolutions from CIF to 20 megapixel (camera dependent) and shall be user selectable. MJPEG, MPEG-4 and H.264 video compression format shall be user selectable depending on the IP camera configured to the IP Server. Video recording shall be available at up to 30 images per second per input channel depending on IP camera type selected.
6. Each NVR shall have a serial port capable of communicating with pan-tilt-zoom (PTZ) cameras.
7. Each NVR shall have two Gbit 1000Base T RJ-45 Ethernet connections for networking to Remote PC clients. Multiple NVR's shall be accessible by multiple clients located anywhere on the network. Each NVR shall record video, audio, and text while displaying live video or playback video. In the event that there is no client actively attached to the NVR, the NVR shall continue to record video and audio, monitor events and all other server functions.
8. Recorded video shall be triggered by the motion detection sensor of the IP camera, an external input device, or in continuous record mode.
9. Each NVR shall have the capability of automatically exporting a predetermined time frame of video to the internal DVD/CD device upon an external trigger input connected to the NVR. Such input shall export to the DVD/CD device a user defined amount of video and video camera source both pre and post event schedulable to the maximum capacity of the DVD/CD media selected.
10. Each NVR shall have the ability to link specific events in an "if-then" scenario. Linked events types shall include video motion, video loss, input trigger, and temperature. Sources of these events shall be any camera connected to the specific server. Action from these events shall include record video, record audio, enable output trigger, output video, notify (send e-mail), and output video to DVD.
11. The NVR hardware shall have an internal DVD/CD device that will allow the server to export video clips to the device in Standalone.Exe (*.exe), AVI files (*.avi) and PS files (*.ps) formats.
12. The NVR shall be configured with RAID-5 storage consisting of a 4U chassis and eight hot swappable hard drives. The RAID-5 storage shall be internal to the server and shall provide notification of a drive failure to the administrator.
 - a. In addition to the previously declared requirements of the NVR. Each NVR shall have a minimum hardware configuration of:
 - 1) Input Voltage:120/240 VAC auto-sensing
 - 2) Power Consumption:480 watts
 - 3) Video Standard:NTSC (30ips) or PAL (25ips)
 - 4) Recording Resolution:CIF to 20 megapixel (camera dependent)
 - 5) Compression:MJPEG, MPEG-4 or H.264 by camera or encoder
 - 6) NIC:2 Gbit 1000Base T RJ-45 (standard), 4 (optional)
 - 7) USB 2.0 Ports: 8 (8 x USB 2.0)
 - 8) RAM 8 GB
 - 9) Hard Drive Storage:4TB, RAID5
 - 10) Processor (2) QuadCore minimum
 - 11) HDMI Output
 - 12) VGA Output:1 DVI-A + 1 DVI-D + 1 Display Port, maximum 2 simultaneous monitors
 - 13) Keyboard & Mouse:Included
 - 14) DVD/CD RW: Included, front panel access

- 15) Operating System: Windows Server 2008 or greater
- 16) Size: 1RU
- 17) Operating Temperature: 40° – 95°F (4.5° – 35°C)
- 18) Relative Humidity: 5 - 95% RH (non-condensing)
- b. Acceptable Manufacturer's and Model
 - 1) Servers shall be provided by the VMS manufacturer. The bidder/contractor shall review and modify as recommended by the VMS manufacturer those servers being provided by the VMS manufacturers.
 - 2) Provide NVR's at the following configuration:
 - a) 1920x1080 camera resolution
 - b) H.264 compression
 - c) (5) frames/sec
 - d) 24 hour by 30% motion
 - e) (30) day storage
 - f) Sized for all cameras this project.

I. Keyboard/Video/Mouse (KVM)

- 1. The unit shall be 1U high and mount in a standard EIA 19" rack mount enclosure or rack.
- 2. The unit shall be compatible with all current versions of the Microsoft Windows operating system.
- 3. The unit shall provide inputs compatible with the computers specified for the NVR servers.
- 4. The unit monitor shall have:
 - a. Size: 17" diagonal
 - b. Technology: Industrial Grade Active Matrix TFT LCD
 - c. Contrast Ratio: 1000:1 (minimum)
 - d. Brightness: 300 cd/m²
 - e. Dot Pitch: .264mm
 - f. Panel Colors: 16.2 million
 - g. Viewing Angle: 160° x 160°
 - h. Video Input: DVI, HDMI
- 5. Acceptable Manufacturer shall be Dell, IBM or HP.
 - a. Provide rack mounted shelf for monitor.

J. Uninterruptable Power Supply (UPS)

- 1. All units whether enclosed in a single housing or utilizing a master slave configuration shall utilize a standard EIA 19" rack mount width and mounting hardware.
- 2. All units shall be designed for operation on a nominal 120VAC system, with an input range of +/- 20%.
- 3. All units shall contain a sealed maintenance free, lead acid battery.
- 4. All units shall provide both local alpha-numeric status display, and accessibility via an RJ-45 connector for remote monitoring and shutdown of the unit. Units shall also contain an audible alarm to be annunciated for all alarm conditions.
- 5. All units shall be compliant with all applicable UL, cUL and IEC ratings and listings.
- 6. All units shall have fully on-line double conversion operation.
- 7. Unless otherwise noted on the Drawings, all units shall be sized for a fifteen minute run time based on the assigned load with a 20% growth factor. Output capacity has been calculated based on the apparent connected load. The Contractor shall verify the actual load prior to bidding based on the Video Surveillance hardware being provided and increase any explicit sizing called for on the drawings based on actual installation conditions at no additional cost to the Owner.

8. All units shall provide an SNMP module and Ethernet interface for remote monitoring and orderly shutdown.
9. Battery capacity shall be provided for a runtime of:
 - a. 15 minutes at full load required by this design intent, plus an additional 20% capacity.
10. Acceptable Manufacturers shall be Powerware, APC or Liebert.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. VSC is responsible for mounting all exterior mounting brackets and devices (either pole mounted or mounted to the building).
- B. Any/All outside components, i.e. power supply, surge suppressers, receiver drivers, shall be mounted in weatherproof boxes (NEMA 3R) with stainless steel or galvanized hardware, unless otherwise accommodated on the inside of the building and fed through to the camera. All penetrations through the building envelope shall be sealed in a weather-tite fashion using a silicon based sealant. Contractor shall coordinate with the General Trades Contractor to ensure all applicable requirements are met.
- C. All exterior devices shall be surge protected by means of a UTP surge protector rated to match the performance criteria of the category of cable used and capable of passing 802.3af standard Power over Ethernet, in addition to the data signaling required.
- D. Surge protection shall be provided at head end equipment and all remote equipment outside of building. All suppresser grounds shall terminate at closest approved grounding electrodes to provide shortest ground path for surges at roof top mounted cameras.
- E. Any structured cabling work required by the Video Surveillance Contractor shall be fully compliant with, and covered under the same warranties as, the structured cabling. As such, the VSC shall coordinate all cabling work with the Electrical Contractor.
- F. All low voltage cable (coax/data/power for cameras) shall be isolated from all line voltage equipment.
- G. All installations shall be installed in a workmanlike manner.
- H. Midspan power injectors shall be utilized for any cameras that must be located outside the range of properly terminated and certified structured cabling distances.
- I. All cables (coax, data, fiber and power circuits) shall be identified with proper tagging and labels.
- J. VSC shall coordinate location of all cameras with Architect.
- K. Initial programming of the Surveillance System shall provide the following operational features:
 1. Remote viewing and reviewing of recorded video by the Administration of the individual school, the District Administration offices and the District Maintenance Offices.
 2. Each user shall be provided an individual viewing screen configuration with the opportunity for the user to reconfigure the screen at their workstation under the supervision of the VSC.

- L. Contractor shall provide and program Video Surveillance System to accept Lockdown input from Access Control System.
 - 1. Contractor shall provide and verify exact Lockdown programming requirements with Owner
- M. All rack mounted units shall be spaced at minimum of 1 ¾-inch apart for ventilation purposes as recommended by manufacturer.
- N. Perform the following start-up tasks:
 - 1. Final aim, focus and adjust all cameras. Confirm proper operation of pan-tilt-zoom, heaters, blowers, and other accessories as may be required.
 - 2. Provide and adjust all lenses as described above. Set shields or filters as necessary.
 - 3. Program all camera identifiers as directed by the Owner.
 - 4. Program any/all analytics or other camera specific operational parameters, such as motion triggers, pre-post record times, etc.
 - 5. Make such other settings and adjustments as required to bring the system on-line and operating in accordance with these Specifications.
 - 6. Verify on-going and uninterrupted operation of all system components from power supply disruptions, i.e. power failures for any one or more component power sources.
- O. Program the graphic command and control module for the operation and features as shown on the Drawings or specified herein. Review desired control operation and schedules with Owner's personnel.
- P. Program the single user interface that shall provide the User with access to both the access control system and the video surveillance system.
- Q. Refer to the Drawings for equipment quantities, locations, and installation details.
- R. VSC shall provide electronic copies of the complete system installation to the SCC. The SCC shall incorporate these into the Operations and Maintenance Manuals to be turned over to the Owner.

3.2 MOUNTING HEIGHTS AND LOCATIONS

- A. In all cases, prior to installation, review all camera locations indicated on the Drawings, and adjust locations to avoid any viewing impediments, and optimize the view of each camera, and the camera system as a whole.

3.3 TRAINING

- A. The contractor shall provide a minimum of forty (40) hours of instruction to personnel designated by the Owner in the proper use, basic care, and maintenance of the equipment. Such training shall be provided as an integral component of the system.
- B. The VSC shall digitally video record the training sessions on standard DVD and provide (2) video copies to the Owner at no additional cost to the Owner.

3.4 WARRANTY

- A. VSC shall provide a three (3) year warranty on installation of all Video Surveillance equipment, transmission devices and connections. Any defective material shall be replaced at no expense to the

Owner including labor, shipping or other required expenses to diagnose and repair any system or component failures.

3.5 SUBMITTALS

- A. Submittals shall include bound brochures with data sheets for all equipment specified and installation drawings. Drawings shall indicate exact wiring requirements and shall include equipment locations shown on floor plans (1/16" scale, minimum). These drawings shall be dedicated solely to indicate the video surveillance system, components and related wiring.

END OF SECTION 28 23 00

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SECTION 283111-FIRE ALARM SYSTEM-ADDRESSABLE**PART 1 – GENERAL****1.1. SUMMARY NETWORK FIRE ALARM CONTROL PANEL (NODE)**

- A. All panels will have the capability to be interfaced in a Peer-to-Peer fashion in the future including the capability to provide a Central Audio Emergency Notification System so that an announcement can be made to any or all Nodes in the event of an emergency. The audio path shall be completely digital from the point of origin out to the respective Nodes. Network fire alarm control panels shall include all features as described in this specification for stand-alone FACP's and shall have network communication capabilities as described herein to be used in the future.
 - 1. All points monitored and controlled by a single node shall be capable of being programmed as "Public". Each point made public to the network may be programmed to be operated by any other node connected to the network.
 - 2. Network communications shall be capable of supporting "point lists" that can be handled as though they were a single point.
- B. The network shall provide a means to log into any node on the system via a laptop computer or CRT/Keyboard and have complete network access (Set Host) for diagnostics, maintenance reporting, and information gathering of all nodes in the system. Systems not meeting this requirement must provide all diagnostic tools required to support this function from selected points on the network. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- C. 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.
- D. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm and detection operations
 - 2. Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.
 - 3. One-way supervised automatic voice alarm operations.

1.2. ACCEPTABLE MANUFACTURERS

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by SimplexGrinnell and represent the base bid for the equipment.
 - 1. Subject to compliance with requirements, provide alternate products by one of the following:
 - a) SimplexGrinnell
 - b) Siemens Fire Safety

- c) Edwards Systems Technology
 - d) 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. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.

1.3. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. The 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. Division 26: Electrical
 - 2. Division 23: Mechanical
- C. The system and all associated operations shall be in accordance with the following:
 - 1. Guidelines of the following Building Code: OBC
 - 2. NFPA 72, National Fire Alarm Code
 - 3. NFPA 70, National Electrical Code
 - 4. NFPA 101, Life Safety Code
 - 5. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
 - 6. Other applicable NFPA standards
 - 7. Local Jurisdictional Adopted Codes and Standards
 - 8. ADA Accessibility Guidelines

1.4. 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. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. 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. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new

configuration download.

- C. 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.
- D. Recording of Events: Record 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 differentiates alarm signals from all other printed indications.
- E. 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, signaling line circuits and notification appliance circuits shall be Class B.
 - 3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- F. Remote Access:
 - 1. FACP shall have the capability to provide Remote Access through a Dial-Up Service Modem using the public switched telephone system of a private switched telephone system.
 - 2. A personal computer or technician's laptop, configured with terminal emulation software shall have the ability to access the FACP for diagnostics, maintenance reporting and information gathering.
 - 3. FACP shall have the capability to provide third party access through a serial interface connection and be agency listed for specific interfaces and for the purpose.
 - 4. FACP shall have the capability to provide remote access via an Internet/Intranet Interface. The Internet interface shall provide an alternative access to system information using the familiar interface of a standard Internet browser. A remotely located fire professional can use this access to analyze control panel status during non-alarm conditions and can also use this information to assist local fire responders during alarm conditions.
- G. Network communication:
 - 1. Network node communication shall be through a token ring configuration.
 - 2. A single open, ground or short on the network communication loop shall not degrade network communications. Token shall be passed in opposite direction to maintain communications throughout all network nodes. At the same time the status of the communication link shall be reported.
 - 3. If a group of nodes becomes isolated from the rest of the network due to multiple fault conditions, that group shall automatically form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with the exact details of the lost communications.

4. The communication method shall be NFPA 72 style 7.

H. 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 FACP 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 Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided under another contract.
4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the location and type of device.
5. Selective Alarm: A system alarm shall include:
 - a) Indication of alarm condition at the FACP and the annunciator(s).
 - b) Identification of the device /zone that is the source of the alarm at the FACP and the annunciator(s).
 - c) Operation of audible and visible notification devices on the fire floor, floor above and floor below until silenced at FACP.
 - d) Selectively closing doors normally held open by magnetic door holders on the fire floor, floor above and floor below.
 - 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) Initiation of smoke control sequence through the building temperature control system.
 - i) Notifying the local fire department.
 - j) Initiation of elevator recall in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated.
6. Supervisory Operations: Upon activation of a supervisory device such as fire pump power failure, 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 FACP historical log.
 - d) Transmission of supervisory signal to remote central 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. 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.
9. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
10. 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 emergency communication connection and any suppression release circuits shall be bypassed for the testing group.
 - b) Control relay functions associated to one of the 8 testing groups shall be bypassed.
 - c) The control unit shall indicate a trouble condition.
 - d) The alarm activation of any initiation 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 or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
- I. Analog Smoke Sensors:
- 1. Monitoring: FACP 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 FACP 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 FACP.
 4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.
 5. The FACP 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 FACP 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 FACP and subsequently a system trouble is reported to the Central Monitoring 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 FACP shall continuously perform an automatic self-test on each sensor which 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.
- J. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.
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 panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
 - 3. Facility for total building paging shall be accomplished by the means of an "All Call" switch.
- M. 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. WSO: 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 is in alarm on the initiating zone.
- N. Power Requirements
 - 1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
 - 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 5 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 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 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 FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.5. SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
 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 FACP, all devices, circuiting and details of graphic annunciator.
 4. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
 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, NAC, relay, Sensor, and auxiliary control circuits.
 6. Operating instructions for FACP.
 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 the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
 9. Record of field tests of system.
- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.

1.6. QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this

section.

- B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.7. MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.
- B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. 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. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.8. EXTRA MATERIALS

- A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
 - 1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
 - 2. Strobe Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
 - 3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.
 - 4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.
 - 5. Printer Ribbons: Furnish 6 spare printer ribbons.

PART 2 – PRODUCTS

2.1. FIRE ALARM CONTROL PANEL (FACP)

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. The following FACP hardware shall be provided:
 - 1. Power Limited base panel with beige cabinet and door, 120 VAC input power.

2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
 3. 2,000 points of Network Annunciation at FACP Display when applied as a Network Node
 4. 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.
 5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.
 6. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output .
 7. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
 8. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
 9. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
 10. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
 11. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
 12. The FACP shall support (6) RS-232-C ports and one service port.
 13. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
 14. Modular Network Communications Card [Future]
 15. Programmable DACT for either Common Event Reporting or per Point Reporting.
 16. Service Port Modem for dial in passcode access to all fire control panel information.
- C. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:
1. Digital 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.
 2. All announcements are made over dedicated, supervised communication lines. All risers shall support Class B wiring for each audio channel.

3. Audio components shall be UL listed with the Main Control panel and bear the same manufacturer's name. Externally mounted or third party audio equipment will not be considered.
 4. 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.
 5. Status annunciator indicating the status of the various voice alarm speaker zones.
 6. Amplifiers shall be capable of switching to any programmed digital audio channel to suit the needs of the Operator. The base system shall have all of the components for two channel.
- D. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 7 (Class A) supervised serial communications channel (SLC):
1. Amplifiers, voice and telephone control circuits
 2. Addressable Signaling Line Circuits
 3. Initiating Device Circuits
 4. Notification Appliance Circuits
 5. Auxiliary Control Circuits
 6. Graphic Annunciator LED/Switch Control Modules
- E. Cabinet: Lockable 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.
- F. 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.

2.2. REMOTE CRTS, PC ANNUNCIATOR AND PRINTERS

- A. Fire Alarm Control Unit shall be capable of operating remote CRT's and/or printers; output shall be ASCII from an RS-232-C connection with an adjustable baud rate.
- B. Fire Alarm Control Unit shall be capable of operating a PC Annunciator which provides status annunciation and limited system control using a convenient and familiar Microsoft Windows® 2000 operating system based interface. PC Annunciator shall provide the following functions:
1. Login/logout password protection with time duration selectable automatic logout
 2. Displays Alarm, Supervisory, Priority 2, and Trouble conditions with numerical tallies for each
 3. Displays first and last alarms
 4. Different event types have separate visible indicators with a common audible indicator

5. Event logs can be searched and printed
 6. View and/or print TrueAlarm status reports and service reports (printing requires an available local or network printer)
 7. Alarm Silence; System Reset; and Priority 2 Reset
 8. Global and individual point acknowledge
 9. Set system time and date; and clear event log
 10. Individual point access for control or parameter revisions
- C. Each RS-232-C port shall be capable of supporting and supervising a remote Printer; the FACP shall support as many as two (2) remote displays. The Fire Alarm Control Panel shall support five (5) RS-232-C ports.

2.3. REMOTE LCD ANNUNCIATOR

- A. Alphanumeric Display and System Controls: Panel shall include an InfoAlarm 320 x 240 point dot matrix (QVGA) LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands. Display choices shall include "First 8 Alarms", "First and most recent", "First 5 and most recent", "Site Plan", "General Alarm" or "Direct to list".
- B. 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.

2.4. NETWORK ANNUNCIATORS [Future]

- A. Network Display Unit shall contain the following features:
1. Alphanumeric Display and System Controls: Panel shall include a 320 x 240 point dot matrix (QVGA) LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands. Display choices shall include "First 8 Alarms", "First and most recent", "First 5 and most recent", "Site Plan", "General Alarm" or "Direct to list".
 2. Capacity to annunciate 12,000 network point and/or point lists.
 3. Historical event logs shall maintain separate 600 Alarm and 600 Trouble events.
 4. The network shall provide a means to log into any node on the system via a laptop computer or CRT/Keyboard and have complete network access (Set Host) for diagnostics, maintenance reporting, and information gathering of all nodes in the system. Systems not meeting this requirement must provide all diagnostic tools required to support this function from selected points on the network.

2.5. 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 indicating devices in alarm or supervisory mode for a period of 5 minutes.

2.6. ADDRESSABLE MANUAL PULL STATIONS

- A. Description: Addressable single-action type red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- B. Protective Shield: Where required provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. 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.

2.7. SMOKE SENSORS

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - 1. Factory Nameplate: Serial number and type identification.
 - 2. Operating Voltage: 24 VDC, nominal.
 - 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - 4. 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. 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.
 - 5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
 - 6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - 7. 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.
 - 8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
 - 9. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
 - 10. Removal of the sensor head for cleaning shall not require the setting of addresses.
- B. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat

type. Where acceptable per manufacturer specifications, ionization type sensors may be used.

- C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.
- D. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
 - 1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
 - 2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
 - 3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
 - 4. Compact 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.
 - 5. 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.
 - 6. Duct Housing shall provide a magnetic test area and Red sensor status LED.
 - 7. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
 - 8. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch located as directed by the fire marshal.
 - 9. Where indicated provide NEMA 4X weatherproof duct housing enclosure 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.

2.8. HEAT SENSORS

- A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- B. 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.
- C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- D. 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.

2.9. ADDRESSABLE CIRCUIT INTERFACE MODULES

- A. Addressable Circuit Interface Modules: Arrange to monitor 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 evacuation indicating appliances and AHU systems.
- B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.
- C. There shall be the following types of modules:
 - 1. Type 1: Monitor Circuit Interface Module:
 - a) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
 - b) 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 FACP.
 - 2. Type 2: Line Powered Monitor Circuit Interface Module
 - a) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing 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 FACP.
 - b) 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.
 - 3. Type 3: Single Address Multi-Point Interface Modules
 - a) 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.
 - b) 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.

- c) 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.

4. Type 4: Line Powered Control Circuit Interface Module

- a) 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.

5. Type 5: 4-20 mA Analog Monitor Circuit Interface Module

- a) This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP 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.

- D. 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 FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.10. 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 develops a minimum of 25 lbs. holding force.
- B. Material and Finish: Match door hardware.

2.11. STANDARD ALARM NOTIFICATION APPLIANCES

- A. 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, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.
- B. 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.
 - 1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC.
 - 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 S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
 4. The S/V installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension
- C. 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 S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
 4. The S/V installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension
- D. 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.

2.12. NAC Power Extender

- A. The IDNet NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class B Style Y rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits.
- B. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
- C. The NAC extender panel may be mounted close to the host control panel or can be remotely located. The IDNET Addressable NAC Extender Panel when connected to an addressable panel shall connect to the host panel via an IDNet communications channel. Via the IDNET channel each output NAC can be individually controlled for general alarm or selective area notification.
- D. For IDNet connected NAC extender panels up to five panels can be connected on a single IDNet channel.
- E. When connected to a conventional (non-addressable panel) one or two standard notification appliance circuits from the main control panel may be used to activate all the circuits on the NAC power extender panel.
- F. Alarms from the host fire panel shall signal the NAC power extender 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.

2.13. EXTRA DEVICES AND APPLIANCES

- A. Provide labor and materials for the following items, which are to be located in the field. These items are in addition to those shown on the drawings. Assume 80 feet of conduit and wiring for each item.

Fire alarm pull station – qty of 10

Fire alarm speaker/strobes – qty of 10

Fire alarm strobe only – qty of 10

Fire alarm smoke detector – qty of 10

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 supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
1. Factory trained and certified personnel.
 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 3. Personnel licensed or certified by state or local authority.
- C. Provide all submittals for the fire department and the building department as required by OBC 907

3.2. EQUIPMENT INSTALLATION

- A. 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, and all other necessary material for a complete operating system.
- B. Existing Fire Alarm Equipment shall be maintained fully operational until the new equipment has been tested and accepted.
- C. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally dispose of the remainder of the existing material.

- D. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
- E. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

3.3. 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 (AH) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. 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.
- C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

3.4. 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. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - 1. Factory trained and certified.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - 3. International Municipal Signal Association (IMSA) fire alarm certified.
 - 4. Certified by a state or local authority.
 - 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- 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. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

- E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
- 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.
- H. Final Test, Certificate 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.

3.5. 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 levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.6. 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 in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
 - 2. Schedule training with the Owner at least seven days in advance.

END SECTION 283111

SECTION 28 48 00 - EMERGENCY RESPONDER RADIO SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide, install, test, document and register a complete and fully operational Emergency Responder Radio System as specified, including, but not limited to, a bi-directional amplifier, donor antenna and mounting structure, lightning protection, passive distribution devices, distribution antennas, cables, connectors and all other Materials and Equipment required to fulfill the performance criteria as indicated herein, and be fully compliant with the requirements outlined in all applicable codes. Note, the specification is a performance based specification for a turn-key installation. It shall be the responsibility of the successful bidder to provide turn-key services that shall include, but not be limited to:
1. Verify and document the required frequency(ies) to be re-broadcast with any/all Emergency Responders within this area of jurisdiction,
 2. Determine and document the location(s) of the appropriate donor tower/repeater,
 3. Ascertain and document through measurement using a calibrated spectrum analyzer the available signal from the aforementioned donor(s) at the best available location on the facility roof,
 4. Create a design that shall provide performance as prescribed herein, optimizing available signal while maximizing signal isolation of the donor from the interior distribution,
 5. Provide any/all required donor antenna(s) and mounting structure(s),
 6. Coordinate the installation of a pre-fabricated roof penetration that shall maintain the warranty and capabilities of the roof structure,
 7. Coordinate a service-able location for the lightening protection and properly bond same to a reliable grounding plane,
 8. Determine and coordinate the use of the best available location for the bi-directional amplifier,
 9. Coordinate the bi-directional amplifier location and required related services such as power,
 10. Provide code required backup power source and requisite interconnections,
 11. Develop and implement the distribution of the signal throughout the entire interior of the new facility,
 12. Provide, locate and interconnect code required alarm points and means of annunciation,
 13. Provide and facilitate testing and sign off by the Authority Having Jurisdiction and any/all Emergency Responders requiring the use of the system,
 14. Complete any/all required registration submissions to the FCC and/or other governing or managing entity.
- B. The required system shall provision all applicable frequencies for Ohio MARCS coverage.

1.02 SECTION INCLUDES

- A. Section Includes:
1. Bi-Directional Amplifiers

2. Backup Power Source
3. Donor Antenna
4. Antenna Mounting Structure
5. Lightning Protection
6. Coaxial Cabling
7. Passive Distribution Devices
8. Distribution Antennas
9. Alarm Panel Interface and Annunciation

1.03 RELATED SECTIONS

- A. Section 27 05 00: Common Work Results
- B. Section 27 05 24: Fire Stopping

1.04 REGULATIONS

- A. Codes, regulations and standards referenced in the Section are:
 1. NFPA 1 – The National Fire Code
 2. NFPA 70 – The National Electrical Code
 3. NFPA 72 – The National Fire Alarm Code
 4. FCC 47 CFR Private Land Mobile Radio
 5. IFC – The International Fire Code

1.05 DEFINITIONS

- A. Definitions:
 1. Bi-Directional Amplifier BDA: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station for enhanced signals and improved coverage.
 2. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
 3. Delivered Audio Quality Definitions (DAQ): This is a universal standard cited in system designs and specifications.
 - a. DAQ 1: Unusable, speech present but unreadable.
 - b. DAQ 2: Understandable with considerable effort. Frequent repetition due to noise/distortion.
 - c. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise/distortion.
 - d. DAQ 3.5: Speech understandable with repetition only rarely required. Some noise/distortion
 - e. DAQ 4: Speech easily understood. Occasional noise/distortion.
 - f. DAQ 4.5: Speech easily understood. Infrequent noise/distortion. \
 - g. DAQ 5: Speech easily understood.

- h. Coupled Bonding Conductor (CBC): a bonding conductor placed, e.g. strapped, on the outside of any technology cable, used to suppress transient noise.
- i. FCC: Federal Communications Commission
- j. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
- k. Public Safety/First Responder: Public Safety or First Responder agencies which are charged with the responsibility of responding to emergency situations. These include, but are not limited to: law enforcement departments, fire departments, and emergency medical companies.

1.06 GENERAL

- A. The completed systems are required to pass proof-of-performance tests as described and specified.
- B. The system shall remain on line regardless of power abnormality or failure for a minimum of 4 hours without disruption or need to cycle power, or reset the system.
- C. All antenna cabling routed from an exterior antenna to an interior point of distribution shall have lightning protection with performance specified for the frequency(ies) of expected operation, as well as the capability to pass DC as may be required for antenna detection for the alarming features of the amplifier and system.
- D. All equipment shall be UL listed and labeled, and accordance with applicable NEMA and ANSI Standards.

1.07 SUBMITTALS

- A. Submit a list of 5 representative projects as described in the Quality Assurance paragraphs below.
- B. Submit a copy of any/all FCC licensing held by the Contractor and/or Project Manager.
- C. Prior to installation, submit to the Engineer for review and approval all calculations and measurements relative to available signal strength at donor antenna location, expected cable lengths, passive device sizing, antenna locations and expected output based on available signal at donor, amplification and link loss.
- D. Submit in accordance with Section 27 05 00, a detailed riser showing the actual installation values of the passive devices, cable lengths and amplifier calibration as a function of the as-built documentation.
- E. The Contractor shall submit to the Owner as a condition of final payment and acceptance, the following documentation:
 - 1. A single reproducible set of drawings of the system, exactly as it was installed with all cable numbers designated on the drawings.
 - 2. Three copies of the test results for the system installed. The test results shall be presented in a printed or typed format in soft cover binders.

3. Contractor shall provide electronic files of the Record Drawing information to the Owner in the Operations and Maintenance Manuals.

1.08 QUALITY ASSURANCE

- A. Contractor Requirements:
 1. All work shall be performed by a qualified radio system contractor holding a valid Contractor's license of a class for the work to be performed.
 2. The Contractor shall be an authorized reseller and service agent of the equipment manufacturer for the equipment being provided.
 3. The Contractor's crew shall be comprised of personnel that are factory trained in the installation and service of the equipment being provided.
 4. Contractor shall have documented experience of having supplied similar systems of like size and complexity for a minimum 5 years. Upon request, the Contractor shall supply a minimum of five references that shall be checked by the Owner. The references include the name of the organization for which the installation was provided, the address of the specific location of the installation being referenced, the name and phone number of a current point of contact, as well as the point of contact at the time of installation, and a description of the system provided
 5. The Contractor shall maintain a local sales and service depot which contains current spare parts stock specifically related to the major system components being provided, as well as test equipment and service vehicles. The aforementioned depot shall be located within a 50 miles radius of the project site with a maximum travel time barring unusual conditions of no greater than 60 minutes.
- B. All wiring enclosures, terminal cabinets, outlets, control boxes, frames of cabinet racks, and other enclosures shall be grounded in compliance with the requirements of the National Electrical Code.

1.09 PERFORMANCE

- A. Signal Strength
 1. Downlink: A minimum signal strength of -95dB shall be provided throughout the coverage area, and a minimum of DAQ 3.0 for either analog or digital signals. The coverage area shall be the entirety of the facility, and shall not be limited to only the area of construction and remodel.
 2. Uplink: A minimum signal strength of -100dBm shall be received at the local First Responder Radio System from the coverage area, and sufficient enough to provide a minimum of DAQ 3.0 for either analog or digital signals.
- B. Contractor shall verify signal strength with local authorities having jurisdiction at the completion of the building envelope (walls, doors, windows, etc) and prior to the installation of the ceiling grid, per the above requirements and all local requirements.
- C. Donor antennas shall maintain a minimum of 20 dB above the interior signal strength under all operating conditions.
- D. Frequency(ies) required shall be coordinated with any/all required First Respondents assigned to this jurisdiction. The Contractor shall obtain a written listing of all applicable

frequencies and licensees of same, verify the frequencies with the licensees, and adapt as required.

- E. Output Level Controls: Automatic Level Control and Automatic Gain Controls shall be included to prevent performance that could either damage and/or inhibit the operation of the system, or its effect on other systems.
- F. The system shall be capable of processing and propagating both analog and digital communications signals simultaneously at the time of installation.
- G. All components, component enclosures and RF emitting devices shall have the certification of the radio licensing authority prior to installation and be compatible with both analog and digital communications, and compatible with any/all required modulations schemes as required by any/all First Responders assigned to this jurisdiction.
- H. The system provided shall be compatible with the radio systems associated with the City of Warrensville Fire Department (WFD). WFD utilizes xxxxxxxxxxxx which deploys radio equipment licensed for both xxxPS and xxxPS radio bands. All Devices, equipment and materials shall be designed specifically to be utilized across the entirety of the xxxPS and xxxPS bands with no exceptions. Upon completion, WFD shall be the entity from whom signed approval shall come. Coordinate all testing and validation with the WFD. Provide any required filtering or other ancillary devices to properly guard interference by or to cellular service while assuring proper operation of the in-building system. Furnish and submit all required registration paperwork to the FCC or other authorities as may be required.

1.10 POWER SUPPLY

- A. The system shall utilize two independent and reliable power supplies, and shall be provided for all equipment required to keep the entire system on-line and operational, one system shall be considered as primary, the other as secondary or backup.
- B. The primary power source shall be by means of a dedicate branch circuit and comply fully with NFPA 72.
- C. The secondary power source shall be storage battery dedicated to the system with the ability to operate the system for 12 hours at 100% capacity.

1.11 SYSTEM MONITORING

- A. The system shall provide monitoring points to assure operational integrity of power supplies and system operation that shall both tie to the fire alarm system, and provide local dedicated annunciation at a location approved by the local authority having jurisdiction.
- B. The communications link between the fire alarm system and the Public Safety Radio Reader System shall be monitored for integrity.
- C. The monitoring points shall be supervisory points and shall be for
 - 1. Donor Antenna malfunction

2. Active RF emitting device failure
 3. Low Battery Capacity indication when 70% of the 12 hour operating capacity has been depleted
 4. System component failure
 5. Normal AC Power Failure
 6. Battery charger failure
- D. A dedicated monitoring panel shall be provided within the fire command center or other location as required by the local authority having jurisdiction. The monitoring panel shall annunciate the ongoing status of all points indicated above and provide an alpha based readout of same. The communications link between this system and the Public Safety Radio Repeater System shall be monitored for integrity.

1.12 WARRANTY

- A. The Contractor shall provide a warranty for all equipment, labor, installation and calibration to be free from defects in materials and workmanship for a period of two (2) years after system is installed and accepted.
- B. Warranty shall be enforced twenty four hours a day seven days a week (24x7x365) with an onsite response time no greater than four (4) hours.
- C. Personnel enforcing the warranty shall be factory authorized agent for said warranty.
- D. The Warranty shall include a retesting and as may be required recalibration in a window of no less than 30 and no more than 60 days from the time of Owner acceptance.
- E. In addition to the warranty prescribed herein, the successful bidder shall also include in their bid submission a maintenance contract that shall have options for both a one year contract and a three year contract. Said contracts shall commence from the first day after the expiration date of the warranty without lapse, and shall include all materials and labor required to continue ongoing coverage of the system as if under the original warranty, i.e. parts and labor, as well as any recalibration that may be required due to component aging or other normal wear and tear factors.

PART 2 - PRODUCTS

2.01 EQUIPMENT STANDARDS

- A. Where applicable all equipment installed under this contract shall be new and listed by UL.

2.02 EQUIPMENT

- A. Bi-directional Amplifiers (BDAs)
 1. The BDAs shall be integrated push pull circuitry housed in a heavy die cast 100% shielded enclosure.
 2. The BDAs shall be equipped with local visual alarms.
 3. The BDAs shall have a low noise figure and wide dynamic range.

4. The BDAs shall have mounting tabs for securing to any flat surface.
5. The BDA's shall be designed specifically for the application for which it is intended, i.e. the BDA associated with that of public safety coverage shall be specifically designed for bi-directional amplification of public safety radio communications, etc., as well as code compliant where required, e.g. the public safety BDA shall be complaint with the International Fire Code (IFC) and NFPA standards and shall be in a NEMA 4 or 4X rated.
6. The BDA upper and lower band pass frequencies shall be as required by the frequencies of the assigned First Responder(s) Radio System plus a guard band both above and below the passband to prevent interference between this system and others operating in close proximity and adjacent channels.
7. The BDAs shall meet or exceed the following performance specifications:
 - a. Gain (Min Attenuation): 60dB
 - b. Gain Flatness: ± 1.5 dB (Max)
 - c. Noise Figure: 3.5 dB (Max)
 - d. Gain Adjustment: 0-30 dB(min) in 2 dB steps (max)
 - e. Power Output @1dB Compression
 - 1) Uplink: +32.0 dBm (Typ)
 - 2) Downlink: +40.0 dBm (Typ)
 - f. Output Power ALC Set
 - 1) Uplink: +25 dBm ± 1
 - 2) Downlink: +33 dBm ± 1
 - g. Output Composite Power
 - 1) Uplink: +25 dBm (Typ)
 - 2) Downlink: +33 dBm (Typ)
 - h. 3rd Order Output Intercept Power
 - 1) Uplink: +46 dBm (Typ) @ 2Tones + 22 dBm each
 - 2) Downlink: +56 dBm (Typ) @ 2Tones + 30 dBm each
 - i. Input Impedance: 50 Ω
 - j. VSWR In/Out: <1.5:1
 - k. Propagation Delay: <1 μ S
 - l. Power Supply: 110VAC-220VAC Autoranging 50 – 60 Hz
 - m. Operating Temperature: -20° C. to +50° C.
 - n. Acceptable Manufacturers shall be:
 - 1) Byrd/TXRX, Cellular Specialties, GWave, Honeywell Notifier

B. Backup Power Enclosure

1. The backup power enclosure shall be a designed assembly that shall either wall mount using mounting tabs permanently affixed to the tops and bottom edges of the assembly, or floor mounted with legs to lift the enclosure up from the floor of the space within which it is housed.
2. The backup power enclosure shall be sized to house the batteries required, plus have clearance above to mount a DIN rail for the power monitoring and regulation devices and terminal strips.
3. The backup power enclosure shall be NEMA 4 or 4X rated.
4. The backup power enclosure shall include DIN rail mounted terminal strips for all cable terminations. Such DIN rail terminal strips shall be for 100% of the terminations of the equipment within, other than the actual battery terminal connections.

5. All terminations within the enclosure shall be labeled with machine generated labels made from material that shall maintain the printing throughout the life of the enclosure.
 6. Any connections made either to the enclosure, or to devices within the enclosure requiring replacement due to periodic standard maintenance shall be connectorized so as to allow quick easy installation and removal.
- C. Donor Antenna(s) Mounting Structure
1. The mounting structure shall be a pre-fabricated exterior grade assembly, that shall be hot-dip galvanized, and non-penetrating.
 2. The mounting structure shall be a ballast type mount having a rectilinear base assembly that is designed to hold concrete cinder blocks as ballast.
 3. The mounting structure shall include a rubberized non-slip pitch pad below to help prevent damage to the roof treatment.
 4. Include an appropriately high mast extension to prevent shadowing by the structure or equipment mounted on top of the structure.
 5. Acceptable manufacturer shall be:
 - a. Rohn, Baird or Solid Signal
- D. Isolation Directional Couplers and Taps:
1. All taps shall be of the directional coupler design. The specified directional couplers and taps shall be N-type or as indicated on the Drawings.
 2. All taps and couplers shall have minimum power capacity of 30W.
 3. All taps and couplers shall have a minimum usable frequency range as dictated by the band utilized by the assigned First Responder
 4. Acceptable Manufacturers
 - a. Byrd, Cellular Specialties, GWave
- E. Combiners/Splitters:
1. Splitters shall be two way and three way and N-type or as indicated on the Drawings.
 2. Splitters shall a minimum of 10W power handling capacity.
 3. Splitters shall have a minimum usable frequency range as dictated by the band utilized by the assigned First Responder.
 4. Acceptable Manufacturer
 - a. Byrd, Cellular Specialties, GWave
- F. Lightning Protection (LP)
1. LP shall have a frequency range that shall be a minimum of the passband of the BDA.
 2. LP shall have a VSWR of <1.1:1
 3. LP shall have an insertion loss of <0.1dB.
 4. LP shall have a maximum surge current of 10kA
 5. LP connectors shall be N-type.
 6. Acceptable manufacturer:
 - a. Polyphaser, l-com or Times Microwave
- G. Antennae, Donor
1. Donor antennas shall be directional.
 2. Donor antennas shall be designed for the passband required as defined above.

3. Donor antenna shall have an adjustable gamma to tune the antenna for minimum VSWR at a frequency at the middle of the passband.
4. Antenna connectors shall be N-type.
5. Acceptable manufacturer and series:
 - a. Comprod, Laird or Byrd

H. Cable

1. Distribution, ½" cable
 - a. The cable shall be a ½" air dielectric corrugated construction with an inner conductor of copper clad aluminum and an annularly corrugated copper outer conductor covered in a flame retardant plenum rated blue sheath.
 - b. The cable shall have a resistance of no more than 0.45Ω/ft on the inner conductor, and no more than 0.58Ω/ft on the outer conductor.
 - c. The cable shall have a characteristic impedance of 50Ω.
 - d. The cable shall have a minimum bending radius of 5 inches.
 - e. Acceptable Manufacturer and Model shall be:
 - 1) RFS, Times Microwave or Commscope
2. Drop, .400 cable
 - a. The cable shall be a .400" construction with an inner conductor of copper, a dielectric of low density PTFE, an outer conductor of aluminum tape, an overall braid of tinned copper and an FRPVC flame retardant plenum rated orange sheath.
 - b. The cable shall have a resistance of no more than 1.8Ω/1000ft on the inner conductor, and no more than 1.65Ω/1000ft on the outer conductor.
 - c. The cable shall have a characteristic impedance of 50Ω.
 - d. The cable shall have a minimum bending radius of 4 inches.
 - e. Acceptable Manufacturer and Model shall be:
 - 1) Times Microwave, RFS or Commscope
3. Coaxial Connectors
 - a. Provide coaxial connectors that are designed for use with the required cabling and which provide continuous maximum radiation security, which exceeds FCC requirements for radiation suppression.
 - b. All connectors shall be a type "N" connector, unless specifically required to be otherwise.
 - c. All connectors shall utilize solder for the inner contact attachment method, and crimp for the outer contact attachment method.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Utilize directional couplers or splitters so as to provide a uniform distribution to all distribution antennas such that the deviation between the signal output of any two antennas is no greater than 3 dB. Simple signal splits without the care of this requirement shall not be acceptable and shall be required to be re-worked at no additional cost to the Owner. Upon testing of system performance, where may be required, relocate and/or add antennas and rebalance system so as to meet this requirement.

- B. Locate antennas so as to minimize and equalize the signal deviation between any/all pairs of antennas to assure even signal distribution across the coverage area.
- C. Route all cabling, back filling any opening requiring fire stopping, or other sealant as required to either maintain the fire rating of the barrier or maintain the seal of the barrier from outside contaminants.
- D. Provide lightning protection for each antenna cable run back into the building at the earliest practical point of entry and ground the lightening protection to the approved grounding busbar.
- E. Install and calibrate as necessary any/all devices.
- F. Install roof penetration pitch pocket under the supervision and approval of the roofing contractor to facilitate continuation of any/all roof warranties.
- G. For cable routed across the roof, provide periodic support devices that shall be non-penetrating and have a rubberized surface on the bottom to protect the roof surface, and have a means by which to attach the cable to maintain spacing no greater than every three feet or as recommended by the cable manufacturer, whichever is less.
- H. All coaxial cable runs shall be continuous between devices. No connectors, fittings, terminations, splices or passive devices shall be installed in any inaccessible location. Said connections shall only be made at outlets, junction- boxes or terminal cabinets or as noted on Drawings.
- I. Properly identify all cabling with machine generated labeling. Verify with the Engineer and Owner the proper labeling schema.
- J. Tag and identify all passive devices, including, but not limited to all passive devices mounted within the ceiling spaces throughout the building. Label the ceiling frame directly below the location of any device mounted in the ceiling spaces. Coordinate the labeling scheme, and font details with Owner prior to labeling.
- K. Where splitters and couplers are mounted in terminal cabinets they shall be mounted using L-brackets with cable connections made in a vertical plane.
- L. Install the backup power source and after sufficient charging time verify operation of the backup power source under load.
- M. All coaxial cables used for interconnection in terminal cabinets shall be tagged and neatly dressed to facilitate servicing and identification.
- N. All coaxial connectors shall be installed using factory recommended tools designed for the connectors being installed.
- O. All equipment shall be mounted securely by means of mechanical attachment at a minimum of four points of attachment. Cables shall not be run horizontally for more than nine inches without being secured. Cables and cords to panel mounted equipment shall all enter from the same side to allow the panel to be swung out for access and service.

- P. All donor and distribution cable shall be routed utilizing sweeping bends of no less than 10 times the radius of the cable.
- Q. All cabling shall be routed straight and smooth with no kinks or other deformations of the cable. Should any segment become kinked or otherwise deformed such that a performance degradation is possible, the Contractor shall replace that entire segment of cable.
- R. Document the results of all coverage testing and include them in the Operations and Maintenance Manuals. Verify coverage, after initial testing and verification of system performance, with any/all First Responders assigned to this jurisdiction. Collect sign off on performance verification with each of these First Responders. Retain a copy on file for the Contractor reference. And, turn the original over to the Owner for their records.
- S. Register the system with the FCC and any other local frequency coordinator as may be required.

3.02 TESTING - DOCUMENTATION - PROOF OF PERFORMANCE

- A. Prior to proof of performance, the Contractor shall test the entire coverage area utilizing the 50 foot grid method. Grids shall be segmented to each of the major building sections as indicated on the Drawings.
 - 1. For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.0 shall be considered a failed test for a given grid cell.
 - 2. Measurements shall be made with the antenna held at 3 to 4 feet above the floor to simulate a typical portable radio work on the belt or turnout coat pocket, including but not limited to circumstances where the orientation of the antenna is perpendicular to the expected polarization of the source.
- B. Verify proper performance, adjust and correct the performance as necessary. Once this has reached an acceptable outcome, perform the proof of performance for the Owner and the First Responder assigned to this jurisdiction.
- C. Before the Contract is considered complete, the Contractor shall demonstrate the performance of the system in the presence to the Engineer, Owner and any/all First Responders assigned to this jurisdiction at no cost to the aforementioned parties. Provide small scale drawings no larger than 11x17 to all parties witnessing the proof of performance testing. The plans shall be divided into the grid utilized for the testing and shall have clearly marked in each grid section the DAQ and signal strength measurements collected during the contractor's system testing. Include in the proof of performance demonstration and proof of performance of the amplifier and the alarm monitoring points both at the fire alarm system and the local annunciator. The First Responder(s) shall be the final judge as to the acceptability/accuracy of the documented DAQ.
- D. The Engineer or Owner may order any changes, adjustments, or further tests deemed necessary to assure that the systems are complete and operational in accordance with the Specifications. Said changes and/or modifications shall be completed in a timely fashion and at no additional cost to the Owner, unless such changes are above and beyond that required to make the system perform to the acceptance of the First Responders assigned to this jurisdiction.

- E. The Contractor shall provide all test and reception gear required to prove the performance as outlined and all costs of test and documentation will be borne by the Contractor.
- F. The Contractor shall provide as built documents in the latest revision of AutoCAD in both electronic and hard copies at full size in the O&M Manual. Provide one additional copy of the as-built documents at the location of the head end equipment.
- G. Correction of Defects: If the Owner or Engineer deems that the system or any part of the system does not meet the specified performance, the Contractor shall conduct further tests including complete sweep analysis to locate faulty or defective components or faulty workmanship. The Contractor shall replace any defective components, parts or cables before further tests are ordered.

END OF SECTION

SECTION 311000 - SITE PREPARATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Stripping and stockpiling topsoil.
 - 4. Removing above- and below-grade site improvements.
 - 5. See Civil, Electrical, Mechanical drawings for utilities.
 - 6. See Architectural drawings for building demolition.

1.03 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. 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.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
- D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site and legally disposed of.

1.06 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.07 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree-protection measures are in place.
- D. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312001 "Site Grading."
 - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

3.03 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.04 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.
- C. Excavate for and remove underground utilities indicated to be removed.

3.05 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.

3. Use only hand methods or air spade for grubbing within protection zones.
 4. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.06 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to 72 inches.
 2. Do not stockpile topsoil within tree protection zones.
 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.07 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

3.08 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Burning tree, shrub, other vegetation, waste, and debris is not permitted.
- C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312001 – SITE GRADING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Excavating and embankment for rough grading the Site.
 - 2. Preparing subgrades for walks, pavements, turf and grasses, and plants.
 - 3. Base course for concrete pavements.
 - 4. Base course for asphalt paving.
- B. Related Requirements:
 - 1. Section 013200 "Construction Progress Documentation" for recording preexcavation and earth-moving progress.
 - 2. Section 311000 "Site Preparation" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
 - 3. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
 - 4. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.
 - 5. Other Civil, Electrical, Mechanical, Architectural, Structural drawings and specifications for earthwork related to building foundations/slabs and/or underground utilities.

1.03 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subgrade and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

- E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- F. Fill: Soil materials used to raise existing grades.
- G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Base Course: Aggregate layer placed between the subgrade hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Project site.
 - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Coordination of Work with utility locator service.
 - b. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Warning tapes.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to project Geotechnical Report.
- C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.07 QUALITY ASSURANCE

- 1. Seismographic monitoring during blasting operations.
- B. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.08 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls" and Section 311000 "Site Clearing" are in place.
- D. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
- E. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

- F. Do not direct vehicle or equipment exhaust towards protection zones.
- G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Per the project Geotechnical Report.
- C. Unsatisfactory Soils: Per the projects Geotechnical Engineer.
- D. Base Course: ODOT #304 limestone only gravel.
- E. Engineered Fill: Per the project Geotechnical Report.
- F. Bedding Course: Refer to Civil drawings for utility trench materials.
- G. Filter Material: #57 washed limestone.
- H. Sand: ASTM C 33/C 33M; fine aggregate.

2.02 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.04 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction as required by the Geotechnical Engineer.

3.05 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.06 SUBGRADE INSPECTION

- A. Notify Architect and Geotechnical Engineer when excavations have reached required subgrade.
- B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Geotechnical Engineer, without additional compensation.

3.07 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Geo.
1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Geotechnical Engineer.

3.08 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.09 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring, bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 - 1. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
 - 2. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.

3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

3.14 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Section 334600 "Subdrainage."

3.15 BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place base course under pavements and walks as follows:
1. Place base course material over subgrade under hot-mix asphalt pavement.
 2. Shape base course to required crown elevations and cross-slope grades.
 3. Place base course 6 inches or less in compacted thickness in a single layer.
 4. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 5. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material classification and maximum lift thickness comply with requirements.
 3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner 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. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area but in no case fewer than three tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 1. Scarify or remove and replace soil material to depth as directed by Geotechnical Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312001

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SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Modification to General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes construction dewatering.
- B. Related Sections include:
 - 1. Section 334000 – Storm Drainage Utilities
 - 2. Section 315000 – Excavation Support and Protection
 - 3. Section 334600 – Subdrainage
 - 4. Section 331100 – Water Utility Distribution Piping
 - 5. Section 333000 – Sanitary Sewerage Utilities

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
 - 1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 5. Remove dewatering system when no longer required for construction.

1.4 SUBMITTALS

- A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 2. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise.
- B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. It is the contractor's responsibility to provide for the design and installation of dewatering systems. It is the contractor's responsibility to make the determination as to when dewatering is necessary.
- C. Field quality-control reports.
- D. Other Informational Submittals:
1. Photographs: Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in dewatering work.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Preinstallation Conference: Conduct conference at Project site.
1. Review methods and procedures related to dewatering including, but not limited to, the following:
 - a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.
 - b. Geotechnical report.
 - c. Proposed site clearing and excavations.
 - d. Existing utilities and subsurface conditions.
 - e. Coordination for interruption, shutoff, capping, and continuation of utility services.
 - f. Construction schedule. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - g. Testing and monitoring of dewatering system.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving 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:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of utility.
 2. Do not proceed with interruption of utility without Construction Manager's written permission.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 2. The geotechnical report is included elsewhere in the Project Manual.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.

- D. Monitor dewatering systems continuously.
- E. Promptly repair damages to adjacent facilities caused by dewatering.
- F. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 01 Section "Temporary Facilities and Controls" during dewatering operations.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
 - 1. Space well points or wells at intervals required to provide sufficient dewatering.
 - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
 - 1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of **36 inches** below overlying construction.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 FIELD QUALITY CONTROL

- A. Observation Wells: Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated; additional observation wells may be required by authorities having jurisdiction.
 - 1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
 - 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 - 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

END OF SECTION 31 23 19

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SECTION 315000 – EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Modification to General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes temporary excavation support and protection systems.
- B. Related Sections include:
 - 1. Section 334000 – Storm Drainage Utilities
 - 2. Section 312319 – Dewatering
 - 3. Section 334600 – Subdrainage
 - 4. Section 331100 – Water Utility Distribution Piping
 - 5. Section 333000 – Sanitary Sewerage Utilities

1.3 PERFORMANCE REQUIREMENTS

- A. Furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 4. Monitor vibrations, settlements, and movements.

1.4 SUBMITTALS

- A. Shop Drawings: For excavation support and protection system.
- B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Other Informational Submittals:

1. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.
 - a. Note locations and capping depth of wells and well points.

1.5 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site.
 1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:
 - a. Geotechnical report.
 - b. Existing utilities and subsurface conditions.
 - c. Proposed excavations.
 - d. Proposed equipment.
 - e. Monitoring of excavation support and protection system.
 - f. Working area location and stability.
 - g. Coordination with waterproofing.
 - h. Abandonment or removal of excavation support and protection system.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving 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:
 1. Notify Engineer no fewer than two days in advance of proposed interruption of utility.
 2. Do not proceed with interruption of utility without Engineer's written permission.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.
 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 2. The geotechnical report is included elsewhere in the Project Manual.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 4 inches.
- D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- F. Tiebacks: Steel bars, ASTM A 722/A 722M.
- G. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
 - 2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earthwork."
 - 3. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 50 00

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Hot-mix asphalt paving.
 - 2. Asphalt joint sealing.
 - 3. Asphalt and concrete pavement markings.
- B. Related Requirements:
 - 1. Section 312001 "Site Grading" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
 - 2. Job-Mix Designs: For each job mix proposed for the Work.
- B. Shop Drawings: For pavement markings.
 - 1. Indicate pavement markings, colors, defined parking spaces, and dimensions to adjacent work.
 - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.

- B. Material Certificates: For each paving material.
- C. Material Test Reports: For each paving material, by a qualified testing agency.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of State of Ohio, Department of Transportation most current Construction and Material Specifications for asphalt paving work, and as modified herein.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Tack Coat: Minimum surface temperature of 60 deg F.
 - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement Marking Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.01 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, or crushed gravel. Slag is not permitted.
- B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, or a combination of the two. Fine aggregate prepared from slag is not permitted.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.02 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320, PG 64-22.
- A. Asphalt Intermediate Course: ODOT Item #448 Asphalt Concrete Intermediate Course, Type 2, PG 64-22, Medium Traffic Design, except that use of reclaimed bituminous aggregate pavement and/or base shall not exceed 20% of the total amount and slag products not permitted.
- B. Asphaltic Surface Course: ODOT Item #448 Asphalt Concrete Intermediate Course, Type 1, PG 64-22, Medium Traffic Design, except that use of reclaimed bituminous aggregate pavement and/or base shall not exceed 10% of the total amount and slag products are not permitted.
- C. Prime Coat: ODOT Item #408.
- D. Tack Coat: ODOT #407.
- E. Water: Potable.
- F. Undersealing Asphalt: ASTM D 3141/D 3141M; pumping consistency.

2.03 AUXILIARY MATERIALS

- A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
- B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.
- C. Sand: ASTM D 1073 or AASHTO M 29, Grade No. 2 or No. 3.
- D. Joint Sealant: ODOT 705.04.

2.04 PAVEMENT-MARKING PAINT

- A. Pavement Marking Paint: ODOT Item #642, Type 1 and 1A fast dry, water based, 100 percent acrylic paint. Type 1A shall be used for cold weather applications (when air and pavement temperatures are between 35 degrees F and 50 degrees F).
 1. Color:

- a. Parking stalls, island striping, lane delineators, crosswalks, and stop bars: White.
 - b. ADA parking stalls and symbols: Blue.
- 2. Application Rate:
 - a. Type 1: 20 Mil Thickness.
 - b. Type 1A: 15 Mil Thickness.
- B. Glass Beads: ODOT Item# 740.09, Type A.

2.05 MIXES

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes ; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 1. Leveling Course: ODOT Item #448, Type 2, PG 64-22.
 - 2. Surface Course: ODOT Item #448, Type 1, PG 64-22.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that base is dry and in suitable condition to begin paving.
- B. Proof-roll base below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated base.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer, and replace with engineered fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.02 PATCHING

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

- B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.03 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared stone base is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.04 PLACING HOT-MIX ASPHALT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.

3. Spread mix at a minimum temperature of 250 deg F.
 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
 2. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.05 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to joints.
 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.06 JOINT SEALANT INSTALLATION

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Joint-Sealant Application: Joints within asphalt paving and between concrete and asphalt paving.
1. Joint Location:
 - a. Joint seal between new or existing concrete and new asphalt paving.
 - b. Joint seal between new or existing concrete curbs and new asphalt paving.

- c. Joint seal between existing asphalt and new asphalt paving.
 - d. Other joints as indicated.
- 2. Joint Sealant: Hot-applied, single-component joint sealant.
 - 3. Joint-Sealant Color: Black.
 - 4. Joint Width: 3 inches, plus or minus 1/2 inch.

3.07 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, but not less than 94 percent or greater than 100 percent.
 - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.08 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
1. Leveling Course: 1/4 inch.
 2. Surface Course: 1/8 inch.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 PAVEMENT MARKING INSTALLATION

- A. Examination:
1. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.

2. Proceed with pavement marking only after unsatisfactory conditions have been corrected.
- B. Installation:
1. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
 2. Allow paving to age for a minimum of 30 days before starting pavement marking.
 3. Sweep and clean surface to eliminate loose material and dust.
 4. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 20 Mil for Type 1 traffic paint and 15 Mil for Type 1A traffic paint.
 - a. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.
 - b. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal..
5. Application shall include 2 coats of pavement markings.

3.11 PROTECTION / CLEANING

- A. Maintain asphalt paving free of stains, discoloration, dirt, and other foreign material. Sweep / clean pavement not more than two days before date scheduled for Substantial Completion inspections.

3.12 WASTE HANDLING

- A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

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SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes Concrete Paving. Including the Following:
 - 1. Driveways.
 - 2. Parking lots.
 - 3. Curbs and gutters.
 - 4. Walks.
 - 5. Wheel stops.
 - 6. Stairs.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
 - 2. Section 321723 "Pavement Markings."

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.
 - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Concrete paving Subcontractor.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Bonding agent or epoxy adhesive.
 - 7. Joint fillers.

1.07 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- C. Standards: Materials and methods of construction shall comply with the following standards:
 - 1. State of Ohio, Department of Transportation Construction & Material Specifications (ODOT), most current edition, unless modified by requirements herein.
 - 2. American Society for Testing and Materials, (ASTM).

3. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 3. Obtain Architect's approval of mockups before starting construction.
 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 5. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
 6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.09 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.02 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.03 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.
- D. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
- E. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A; coated, plain.
- F. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 plain-steel bars.
- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

- H. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

2.04 CONCRETE MATERIALS

- A. Regional Materials: Concrete shall be manufactured within 500 miles of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I.
 - 2. Fly Ash: Not permitted.
 - 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
- A. Coarse Aggregates: Washed, uniformly graded limestone only aggregate. Provide aggregates from a single source.
 - 1. Size: #57 or #8 washed limestone only.
 - 2. No slag or recycled concrete aggregate permitted.
- B. Fine Aggregate: Natural sand free of materials with deleterious reactivity to alkali in cement, in accordance with ASTM C33.
- C. Air-Entraining Admixture: ASTM C 260/C 260M.
- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
- E. Water: Potable and complying with ASTM C 94/C 94M.

2.05 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.
 - 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. Euclid Chemical Company (The); an RPM company.
 - b. FORTA Corporation.

2.06 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ChemMasters, Inc; Safe-Cure Clear DR.
 - b. Dayton Superior; Clear Resin Cure J11W.
 - c. Euclid Chemical Company (The); an RPM company; Kurez DR VOX.
 - d. L&M Construction Chemicals, Inc; L&M CURE R.
 - e. Lambert Corporation; AQUA KURE - CLEAR.
 - f. W.R. Meadows, Inc; 1100-CLEAR SERIES.

2.07 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.08 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- B. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum W/C Ratio at Point of Placement: 0.50.
 - 3. Slump Limit: 1 to 3 inches, plus or minus 1 inch. Nominal slump may be increased to 6 inches, provided the increase in slump is achieved by adding chemical admixture.
- C. Prepare design mixtures, using one or a combination of the following mixtures:

1. Exterior Concrete Mixture #1 using 57's (Use only between April 1 and October 15):
 - a. Cement content:
 - 1) 385 lb. Portland cement.
 - 2) 165 lb. GGACBF Slag cement.
 - b. Course aggregate: 1670 lb. #57's limestone only.
 - c. Fine aggregate: 1310 lb.
 2. Exterior Concrete Mixture #2 using 8's (Use only between April 1 and October 15):
 - a. Cement content:
 - 1) 385 lb. Portland cement.
 - 2) 165 lb. GGACBF Slag cement
 - b. Course aggregate: 1480 lb. #8's limestone only.
 - c. Fine aggregate: 1410 lb.
 3. Exterior Concrete Mixture #3 using 57's (Use only if construction schedule prohibits the use of mixture 1 or 2):
 - a. Cement content: 600 lb. Portland cement.
 - b. Course aggregate: 1610 lb. #57's limestone only.
 - c. Fine aggregate: 1270 lb.
 4. Exterior Concrete Mixture #4 using 8's (Use only if construction schedule prohibits the use of mixture 1 or 2):
 - a. Cement content: 600 lb. Portland cement.
 - b. Course aggregate: 1610 lb. #57's limestone only.
 - c. Fine aggregate: 1270 lb.
 5. Use a qualified independent testing agency for preparing and reporting concrete design mixtures.
- D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 6 percent plus or minus 2 percent.
- E. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture and retarding admixture in concrete as required for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

- G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd..

2.09 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.10 WHEEL STOPS

- A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
 - 1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
 - 2. Mounting Hardware: Galvanized-steel spike or dowel, 1/2-inch diameter, 24-inch length.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312001 "Site Grading."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

3.05 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints (Expansion Joints): Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate expansion joints as indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Place top of joint filler flush with finished concrete surface.
 4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
- A. Contraction Joints (Control Joints): Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks. Route joint with chamfering device that provide a total 5/8" bevel width.
- B. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.07 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.08 DETECTABLE WARNING INSTALLATION

- A. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete immediately after screeding concrete surface.

3.09 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.

- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by curing compound as follows:
 - 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
 - 4. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 5. Joint Width: Plus 1/8 inch, no minus.

3.11 WHEEL STOP INSTALLATION

- A. General: Install wheel stops according to manufacturer's written instructions unless otherwise indicated.
- B. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at

least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests at contractor's expense: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321816.13 - PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Engineered wood fiber play surface.
 - 2. Alternate Bid #4 – Rubberized Play Surfacing.

1.03 DEFINITIONS

- A. Definitions in ASTM F 2223 apply to Work of this Section.
- B. Critical Height: Standard measure of shock attenuation according to ASTM F 2223; same as "critical fall height" in ASTM F 1292. According to ASTM F 1292, this approximates "the maximum fall height from which a life-threatening head injury would not be expected to occur."

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of protective surfacing.
 - 1. Location of wear mats in organic loose-fill surfaces.
- C. Samples for Initial Selection: For each type of exposed finish.
 - 1. Include similar samples of playground surface system and accessories involving color selection.
- D. Samples for Verification: For each type of playground surface system indicated:
 - 1. Minimum 1-quart loose-fill surface sealed in a container.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of unitary surfacing product.

- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For playground protective surfacing to include in maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.08 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace components of protective surfacing that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Reduction in impact attenuation as measured by reduction of critical fall height.
 - b. Deterioration of protective surfacing and other materials beyond normal weathering.
 - 2. Warranty Period: Five years from date of Substantial Completion or installation, whichever is later.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain protective surfacing materials from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Impact Attenuation: Critical fall height tested according to ASTM F 1292.
- B. Accessibility Standard: Minimum surfacing performance according to ASTM F 1951.

2.03 WOOD FIBER PLAY SURFACE AND ACCESSORIES

- A. Engineered Wood Fibers: Random-sized wood fibers, in manufacturer's standard fiber size, approximately 10 times longer than wide; containing no bark, leaves, twigs, or foreign or toxic materials according to ASTM F 2075; graded according to manufacturer's standard

specification for material consistency for playground surfaces and for accessibility according to ASTM F 1951.

1. Available Products:
 - a. GameTime; GT Impax Fiber.
 - b. SofFall Incorporated; SofFall.
 - c. Zeager Bros., Inc.; Wood Carpet
 2. Critical Height: As required for submitted play structures.
 3. Uncompressed Material Depth: Not less than as required for critical height indicated.
- B. Stabilizing Mats: Manufacturer's standard, water-permeable PVC or rubber mats tested for impact attenuation according to ASTM F 1292, and rated for use in the following locations, with anchoring system designed to anchor mat securely to subgrade through engineered wood:
1. Location: At excessive wear areas and as follows:
 - a. Below top of loose-filled surface.
 - b. Under and in front of slide exits.
 - c. At finished grade around transfer stations at accessible perimeter.
 2. Size: 36 x 36 inches.
 3. Color: as selected from manufacturer's full range.

2.04 ALTERNATE BID #4 - POURED IN PLACE RUBBER PLAY SURFACING

- A. Seamless Surface: Dual-density, poured-in-place system with wearing course over impact course. Provide manufacturer's standard thickness for each layer as required for overall thickness indicated, tested for impact attenuation according to ASTM F 1292-04 and for accessibility according to ASTM F 1951-08.
1. Available Products:
 - a. GameTime; GT Impax Poured.
 - b. Safe Guard Surfacing Corp.; Poured in Place.
 - c. SpectraTurf, Inc.; Spectra Pour.
 2. Wearing Course: EPDM rubber particles and polyurethane.
 3. Cushion Course: Formulation of 100% recycled SBR particles and polyurethane, site mixed and applied.
 4. Binder: Weather-resistant, UV-stabilized, flexible, nonhardening, 100 percent solids polyurethane complying with requirements of authorities having jurisdiction for nontoxic and low VOC content.
 5. Overall Thickness: Per equipment height requirements. Not less than indicated.
 6. Primer/Adhesive: Manufacturer's standard primer and weather-resistant, moisture-cured polyurethane adhesive suitable for unit, substrate, and location indicated.
 7. Wearing Course Color(s):
 - a. Color: As indicated on Drawings.

- B. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

2.05 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for subgrade elevations, slope, and drainage and for other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and without high spots, ridges, holes, and depressions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.06 PREPARATION

- A. Prepare substrates to receive surfacing products according to protective surfacing manufacturer's written instructions.

2.07 INSTALLATION OF WOOD FIBER PLAY SURFACE SYSTEMS

- A. Loose Fill: Place playground surface system materials including manufacturer's standard amount of excess material for compacting naturally with time to required depths after Installation of playground equipment support posts and foundations.
- B. Stabilizing Mats: coordinate installation of mats and mat anchoring system with placing of loose-fill.
- C. Compacting and Grading: Uniformly compact and grade loose-fill according to manufacturer's written instructions to an even surface from irregular surface changes as indicated.
- D. Finish grading: Hand rake to a smooth finished surface and to required elevations.

2.08 INSTALLATION OF POURED IN PLACE SURFACING

- A. Mix and apply components of seamless surfacing according to manufacturer's written instructions to produce uniform, monolithic, and impact-attenuating protective surfacing of required overall thickness.
 - 1. Substrate Primer: Apply over prepared substrate at manufacturer's standard spreading rate for type of substrate.
 - 2. Poured Cushioning Layer: Spread evenly over primed substrate to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation, with a minimum of cold joints.
 - 3. Intercoat Primer: Over cured cushioning layer, apply primer at manufacturer's standard spreading rate.

4. Wearing Layer: Spread over primed base course to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation and, except where color changes, with no cold joints. Finish surface to produce manufacturer's standard wearing-surface texture.
 - a. Design: Where colored pattern is required, place colored, design material as soon as previously placed material is sufficiently cured, using primer or adhesive if required by manufacturer's written instructions.
5. Lacquer Topcoat: Spray or roller applied at manufacturer's standard coating rate in one continuous operation.
6. Edge Treatment: As indicated on Drawings. Fully adhere edges to substrate with full coverage of substrate. Maintain fully cushioned thickness required to comply with performance requirements.

2.09 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests.
- B. Perform the following tests with the assistance of a factory-authorized service representative:
 1. Perform "Installed Surface Performance Test" according to ASTM F 1292 for each protective surfacing type and thickness in each playground area.
 2. Perform installed-surface-performance tests at no less than one series of tests for each 1000 sq. ft. of each type and thickness of in-place protective surfacing or part thereof.
- C. Playground protective surfacing will be considered defective if it does not pass tests.
- D. Prepare test reports.

END OF SECTION 321816.13

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SECTION 323119 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Decorative steel fences.
 - 2. Swing gates.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for post concrete fill.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Include 10-foot length of fence complying with requirements.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 DECORATIVE METALLIC-COATED-STEEL TUBULAR PICKET FENCES

- A. Decorative Metallic-Coated Steel Tubular Picket Fences: Comply with ASTM F 2408, for light industrial (commercial) application (class) unless otherwise indicated.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product meeting the following requirements:
- a. Fence Framework (Pickets, Rails, and Posts): Hot-dip galvanized steel conforming to the requirements of ASTM 924/a924m, with a minimum yield strength of 45,000 psi. The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft² (276 g/m²), coating designation G-90.
 - b. Posts Size: As indicated.
 - c. Post Caps: Formed from steel sheet and hot-dip galvanized after forming.
 - d. Rails: Double-wall channels, size as indicated.
 - e. Pickets: Square tubes.
 - f. Terminate tops of pickets at top rail for flush top appearance.
 - g. Picket Spacing: As indicated.
 - h. Fasteners: Manufacturer's standard concealed fastening system.
 - i. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
 - j. Manufacturer's standard finish: a thermal stratification (multi-stage, high-temperature, multi-layer) electrostatic powder coating application system of both epoxy and polyester.
 - 1) Color: Black.

2.02 SWING GATES

- A. Gate Configuration: As indicated.
- B. Gate Frame Height: As indicated.
- C. Gate Opening Width: As indicated.
- D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes 2-1/2 by 2-1/2 inches formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
- E. Frame Corner Construction: Welded and 5/16-inch-diameter, adjustable truss rods for panels 5 feet wide or wider.
- F. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

- G. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide strongarm double latch allowing padlocking to be accessible from both sides of gate.
- H. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
 - 1. Function: 320 - Gate spring pivot hinge. Adjustable tension.
 - 2. Material: Coated steel.
- I. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.
- J. Metallic-Coated-Steel Finish: High-performance coating.

2.03 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.
- B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.04 METALLIC-COATED-STEEL FINISHES

- A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.
- B. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a zinc-phosphate conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.
- C. High-Performance Coating: Apply epoxy primer, polyurethane intermediate coat, and polyurethane topcoat to prepared surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, underground structures, benchmarks, and property monuments.
 - 1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.03 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil.
- D. 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 and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Finish and slope top surface to drain water away from post.
 - 3. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post.
 - a. Extend posts into concrete as indicated.
 - b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, non-metallic grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
 - 4. Space posts uniformly as indicated.

3.04 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.05 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.

3.06 DEMONSTRATION

- A. Train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION

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SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes:
 - 1. Amended topsoil.
 - 2. Planting soil.
- B. Related Requirements:
 - 1. Section 31 10 00 "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Section 32 92 00 "Turf and Grasses" for placing amended topsoil for turf and grasses.
 - 3. Section 32 93 00 "Plants" for placing planting soil for plantings.

1.03 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- B. CEC: Cation exchange capacity.
- C. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- D. Planting Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- E. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- F. Amended Topsoil: Existing, on-site topsoil that has been modified as specified with soil amendments and fertilizers to produce a soil mixture for lawn growth.
- G. 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.
- H. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

- I. 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.

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 test data substantiating that products comply with requirements.
 - 2. Material Certificates: For each type of soil amendment and fertilizer before delivery to the site, according to the following:
 - a. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
 - b. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Amended 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; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
- C. Planting Soil 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; deleterious material; pH; and mineral and plant-nutrient content of planting soil.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.

1.07 QUALITY ASSURANCE

- A. 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.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil.
 - 1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each unamended existing topsoil to be used for the re-spreading of amended topsoil, perform testing on 3 soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a

qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.09 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Architect under the direction of the testing agency.
 1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for topsoil to be amended for topsoil purposes.
 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
 3. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
- C. Chemical Testing:
 1. Soil pH Level.
 2. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- D. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- E. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
 1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inchdepth of soil.
 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inchdepth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Regional Materials: Soil amendments and fertilizers shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

2.02 AMENDED TOPSOIL

- A. Amended Topsoil: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce amended topsoil for new lawns. Amend existing, on-site surface soil with soil amendments and fertilizers to meet the following requirements:
 - 1. Loose, friable, natural, fertile soil, free of stones, clay lumps, roots, and foreign or toxic matter.
 - 2. Classified in the "Sandy Loam" portion of the U.S.D.A. Soil Textural Triangle. The fraction passing the #10 sieve shall meet the following mechanical analysis:
 - a. 10 to 20% clay (less than 0.002 mm particle size).
 - b. 50 to 60% sand (2.0 to 0.05 mm particle size).
 - c. 20 to 30% silt (0.05 mm to .002 mm particle size).
 - 3. Contain neither less than 6%, nor more than 15%, organic matter as determined by loss on ignition of samples oven-dried to constant weight at 212° F.
 - 4. Have a pH level of between 6.8 and 7.3.
 - 5. All topsoil shall be screened through a 1" screen.
- B. If amended topsoil test results indicate the soil does not meet the requirements listed above, contractor shall amend the soil further, and retest the soil. Contractor shall repeat this process until the soil meets the specifications.

2.03 PLANTING SOIL

- A. Planting Soil: Planting soil shall meet the following requirements:

1. Consists of equal parts (by volume) of the following:
 - a. Topsoil.
 - b. Sharp, clean bedding sand conforming to ASTM C-33.
 - c. Organic Soil Amendment.
2. Mechanically combined by a supplier with at least five years' experience in similar blending work. Contractor must provide Owner's Representative with certification letter from supplier.
3. Final blend from Part 1 above shall be classified in the "Sandy Loam" portion of the U.S.D.A Soil Textural Triangle. For Growing Medium to be classified as "Sandy Loam," that fraction passing the #10 sieve shall meet the following mechanical analysis:
 - a. 50 to 75% sand (2.0 to 0.05 mm particle size).
 - b. 15 to 45% silt (0.05 mm to 0.002 mm particle size).
 - c. 4 to 20% clay (less than 0.002 mm particle size).
4. pH between 6.8 and 7.3.
5. Organic content between 15 and 30%.

2.04 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
 2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.05 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
 1. Feedstock: Limited to leaves.
 2. Reaction: pH of 5.5 to 8.
 3. Moisture Content: 35 to 55 percent by weight.
 4. Organic-Matter Content: 50 to 60 percent of dry weight.
 5. Particle Size: Minimum of 98 percent passing through a 1/2-inch sieve.

PART 3 - EXECUTION

3.01 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.

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

3.02 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area and stockpile until amended.
- 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. Screening: Pass unamended soil through a 1-1/4 inch sieve to remove large materials.

3.03 PLACING AND MIXING TOPSOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce amended topsoil. 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 4 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth indicated on Drawings, 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 evenly on surface, and thoroughly blend them with unamended soil to produce amended topsoil.
- D. Compaction: Compact each blended lift of amended topsoil to 85 percent of maximum Standard Proctor density according to 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.

3.04 PLACING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply planting soil on-site in its final, blended condition. 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 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

- C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.
- 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.

3.05 FIELD QUALITY CONTROL

- A. Soil will be considered defective if it does not pass tests.
- B. Prepare a minimum of 3 test reports for amended topsoil, and planting soil indicating they are in compliance with requirements.
- C. 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.

3.06 PROTECTION

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

3.07 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
 - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Hydroseeding.
 - 3. Turf renovation.
 - 4. Erosion-control material(s).
 - 5. Transition mats.
- B. Related Requirements:
 - 1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
 - 2. Section 334600 "Subdrainage" for below-grade drainage of landscaped areas.

1.03 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- C. Amended Topsoil: Existing, on-site 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.
- D. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.

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

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress. Supervisor on the Project must be an "Ohio Certified Nursery Technician" if the project occurs in the State of Ohio.
 - 2. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.07 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.

1.08 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.01 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:

1. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
 - a. 70 – 80 percent Turf Type Tall Fescue blend of four improved varieties (minimum), with Rhizomes.
 - b. 20 – 30 percent Kentucky Bluegrass (*Poa Praetensis*)

2.02 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 1. Type A composition: Starter fertilizer containing 18% nitrogen, 24% phosphoric acid, and 6% potash by weight (18-24-6), or similar approved composition.
 2. Type B composition: Top dressing fertilizer containing 31% nitrogen, 3% phosphoric acid, and 10% potash by weight (31-3-10), or similar approved composition.

2.03 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- D. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.04 HERBICIDES

- A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.05 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

- B. Transition Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface. Include manufacturer's recommended anchorage system for slope conditions. Basis-of-Design Product: Subject to compliance with requirements, provide Hanes Geo Components – “Scourstop” or a comparable product meeting the following requirements:
1. General: Transition mat shall be a semi-rigid mat which provides impact resistance and high tensile strength. When anchored the transition mat shall maintain soil contact while providing a minimum of 40 lbs of holding capacity per square foot to resist uplift forces due to high velocity
 2. Material: HDPE (High Density Polythylene).
 3. Size: 4' x 4' x ½ inch.
 4. Weight: .93 lbs/ sq. ft.
 5. Open Space (Voids): Mat shall have 50% open space for vegetation growth.
 6. UV Stability: 90% minimum.
 7. Anchors: Manufacturers standard anchoring system.
 8. Performance Requirements:
 - a. Velocity Day 1: 19.0 ft./sec.
 - b. Velocity Fully Vegetated: 31.0 ft./sec.
 - c. Shear Day 1: 13.0 lb/ sq. ft.
 - d. Shear Fully Vegetated: 16.0 lb/ sq. ft.
- C. Turf Reinforcement Mat (TRM): Dense web of crimped, interlocking, multi-lobed polypropylene fibers position between two biakially oriented nets and mechanically bound together by parallel stitching. Include manufacturer's recommended anchorage and installation for conditions. Basis-of-Design Product: Subject to compliance with requirements, provide Hanes Geo Components – “Turf Reinforcement Mat (TRM”, or approved equal by one of the following manufacturer's:
1. Contech Engineered Solutions.
 2. Nilex Inc.
 3. Tensar International Corporation.

PART 3 - EXECUTION

3.01 EXAMINATION

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

- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.02 PREPARATION

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

3.03 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- A. Starter Fertilizer: Apply Type A Fertilizer on surface of topsoil and thoroughly blend into amended topsoil.
 - 1. Rate: 1.0 lb. of actual nitrogen per 1,000 sq. ft. (220 lbs./acre).
 - 2. Delay mixing fertilizer with topsoil if planting will not proceed within a few days of application.
- B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For transition mat, install mat and fasten as recommended by material manufacturer.
- C. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- D. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.05 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft..
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:6 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with transition mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying amended topsoil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.06 HYDROSEEDING

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

3.07 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf.

Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow lawn to a height of 2 to 3 inches.
- A. Lawn Postfertilization: Apply Type B fertilizer to lawns approximately 30 days after seeding at a rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (140 lbs./acre.). Apply with mechanical rotary or drop type distributor. Thoroughly water into soil.

3.08 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.09 HERBICIDE APPLICATION

- A. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

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

3.11 MAINTENANCE SERVICE

- A. Lawn Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Lawn Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 - 1. Seeded / Hydroseeded Lawn: 6 months from date of planting completion or Substantial Completion, whichever is later.
 - a. When initial maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

END OF SECTION

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Plants.
 - 2. Tree stabilization.
 - 3. Tree-watering devices.
 - 4. Weed barrier.
- B. Related Requirements:
 - 1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
 - 2. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.03 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

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

1.04 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.05 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

1.07 INFORMATIONAL SUBMITTALS

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

2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Sample Warranty: For special warranty.

1.08 CLOSEOUT SUBMITTALS

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

1.09 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
 2. Landscape supervisor on the project must be an "Ohio Certified Nursery Technician" if the project occurs in the State of Ohio.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
- D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

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

3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 2. Do not remove container-grown stock from containers before time of planting.
 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

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

1.12 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth.
 - b. Structural failures including plantings falling or blowing over.
 2. Warranty Periods: 1 year from date of planting completion or Substantial Completion, whichever is later.
 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. Provide extended warranty for 1 year, for replaced plant material.

PART 2 - PRODUCTS

2.01 PLANT MATERIAL

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

- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.02 FERTILIZERS

- A. Fertilizer Type "A": Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen.
 - 1. Composition: 5% nitrogen, 10% phosphoric acid, and 5% potash by weight (5-10-5).
- B. Fertilizer Type "B": Owner's Representative-approved acid-base fertilizer.

2.03 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: Grade A, 6-month old well rotted shredded native hardwood bark mulch not larger than 4" in length and 1/2" in width, free of wood chips and sawdust.

2.04 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
- B. Composite Fabric: Commercial grade, woven, needle-punched polypropylene fabric with reinforcing fibers, minimum 5.0 oz./sq. yd. Subject to compliance with requirements, provide one of the following:
 - 1. "Pro-5 Weed-Barrier" as manufactured by DeWitt Company
 - 2. "500 Series Landscaper's Choice" as manufactured by Ground cover Industries, Inc.
 - 3. "Pro Platinum Plus" as manufactured by Hanes Geo Components.

2.05 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 - 1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
 - 2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter, with rubber hose guards where connecting to tree.

2.06 TREE-WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
 - 1. Color: Black or green.

2.07 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Burlap: Non-synthetic, biodegradable.
- C. 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 plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Trunk Wrapping: Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.
- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.03 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting pit as indicated on drawings.
- B. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits as indicated on drawings.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.05 TREE, AND SHRUB VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball

to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
 - 1. Backfill: Planting soil.
 - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 4. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
 - 1. Backfill: Planting soil.
 - 2. Carefully remove root ball from container without damaging root ball or plant.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 4. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.06 TREE, AND SHRUB VINE 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 Architect.
- C. Do not apply pruning paint to wounds.

3.07 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.08 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.09 PLANTING AREA MULCHING

- A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 12 inches and secure seams with galvanized pins.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
 1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 6 inches of trunks or stems.
 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.10 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.11 PLANT MAINTENANCE

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

3.12 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

3.13 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.14 MAINTENANCE SERVICE

- A. Maintenance Service for Trees, Shrubs, and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: Three months from date of planting completion or Substantial Completion, whichever is later.

END OF SECTION

SECTION 331100 – WATER UTILITY DISTRIBUTION PIPING

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 SECTION INCLUDES

- A. Water-distribution piping and specialties outside the building for the following
 - 1. Water services
 - 2. Fire-service mains
 - 3. Combined water service and fire-service mains
 - 4. Vault, valves and materials
 - 5. Fire hydrants
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.
- C. Related Sections
 - 1. Section 310000 – Earthwork.
 - 2. Section 315000 – Excavation Support and Protection
 - 3. Section 312319 – Dewatering

1.3 REFERENCES

- A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop.
- B. ANSI/ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18" (457 mm) Drop.
- E. ANSI/AWS A5.8 - Brazing Filler Metal.
- F. ANSI/AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
- G. ANSI/AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other liquids.

- H. ANSI/AWWA C111- Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
- I. ANSI/AWWA C150 - Thickness Design of Ductile Iron Pipe.
- J. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- K. ANSI/AWWA C158 - Ductile Iron Compact Fittings, 3 inches Through 24 inches and 54 inches Through 64 inches for Water Services.
- L. ANSI/AWWA C500 - Gate Valves, 3 through 48 in NPS, for Water and Sewage Systems.
- M. ANSI/AWWA C502 - Dry Barrel Fire Hydrants.
- N. ANSI/AWWA C504 - Rubber Seated Butterfly Valves.
- O. ANSI/AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in through 24 in NPS.
- P. ANSI/AWWA C509 - Resilient Seated Gate Valves 3 in through 12 in NPS, for Water and Sewage Systems.
- Q. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Appurtenances.
- R. ANSI/AWWA C606 - Grooved and Shouldered Type Joints.
- S. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- T. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
- U. UL 246 - Hydrants for Fire - Protection Service.

1.4 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Product Data: Provide data on pipe materials, pipefittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1.
- B. Accurately record actual locations of piping mains, valves, connections, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with utility company and municipal authority.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 1.
- B. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 PIPE

- A. Ductile Iron Pipe: ANSI/AWWA C104:
 - 1. Fittings: Ductile iron, Class 52, standard thickness.
 - 2. Joints: ANSI/AWWA C111, rubber gasket with rods.
 - 3. Polyethylene encasement: Eight mil thick polyethylene tube manufactured in accordance with ANSI/AWWA C105/A21.5. Polyethylene adhesive tape, 1 ½" wide to seal joints.
 - 4. Requirements of Aqua Ohio, Inc. shall govern.
- B. Copper Tubing: ASTM B88, Type-K; annealed.
 - 1. Fittings: ANSI/ASME B16.18, cast copper or ANSI/ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or ANSI/AWS A5.8, BcuP silver braze.
 - 3. Requirements of Aqua Ohio, Inc. shall govern.

2.2 GATE VALVES - 3" (75 mm) and Over

- A. ANSI/AWWA C500, Iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, post indicator, extension box and valve key. Requirements of Aqua Ohio, Inc. shall govern.
- B. ANSI/AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, post indicator, extension box and valve key. Requirements of Aqua Ohio, Inc. shall govern.

2.3 HYDRANT

- A. Hydrant: Mueller Centurion A-423-539382 as required by the local fire department and Aqua Ohio, Inc.
- B. Hydrant Extensions: Fabricate in multiples of 6" with rod and coupling to increase barrel length.
- C. Hose and Steamer Connection: Match sizes with utility company or fire authority, two hose

nozzles, one pumper nozzle.

- D. Finish: Primer and two coats of enamel to color required by utility company or fire authority.
- E. Requirements of Aqua Ohio, Inc. shall govern.

2.4 BEDDING MATERIALS

- A. Bedding: Fill, as specified in Section 310000, natural stone, washed, free of deleterious material graded to maximum size of 5/8" and minimum size 1/4".

2.5 ACCESSORIES

- A. Concrete for Thrust Blocks: Concrete type specified in Section 033000.
- B. Backflow Preventer: Reduced pressure type as required.
- C. Meter: As required by Aqua Ohio, Inc.
- D. Requirements of Aqua Ohio, Inc. shall govern.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions under provisions of Division 1.
- B. Verify that municipal utility water main size, location and invert are as indicated.

3.2 PREPARATION

- A. Ream pipe and remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 310000 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 8" compacted depth and compacted in accordance with Section 310000.
- C. Backfill around sides and to top of pipe with fill tamped in place and compacted in accordance with

Section 310000.

- D. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION – PIPE

Install all pipe as indicated by plans and details and in accordance with Aqua Ohio, Inc.

- A. Maintain separation of water main from storm and sanitary sewer piping in accordance with municipal code and E.P.A. requirements.
- B. Install pipe to indicated elevation to within tolerance of 1/2".
- C. Install piping and fittings to ANSI/AWWA C605.
- D. Route pipe in straight line.
- E. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- F. Install access fittings to permit disinfection of water system performed under Section 331100.
- G. Slope water pipe and position drain at low points.
- H. Form and place concrete for thrust blocks at each elbow or change of direction of pipe main.
- I. Establish elevations of buried piping to ensure not less than five (5') feet of cover.
- J. Backfill trench in accordance with Section 310000.

3.5 INSTALLATION - VALVES AND HYDRANTS

Install all valves and hydrants in accordance with the plans and details and in accordance with Aqua Ohio, Inc.

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb and locate pumper nozzle perpendicular to roadway.
- D. Set hydrants to grade, with nozzles at least 20" above proposed finished grade.
- E. Locate control valve 18" away from hydrant.
- F. Provide a drainage pit per detail filled with minimum of 8 c.f. of #57 washed limestone. Encase elbow of hydrant in gravel to 150 mm above drain opening. Do not connect drain opening to sewer.
- G. Paint hydrants in accordance with local fire authority requirements and Aqua Ohio, Inc.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. After lines have been pressure tested, flush out each run of pipe thoroughly, to remove all foreign matter from the lines. Disinfect in accordance with AWWA C651 and as directed by the water utility.
- B. The Contractor shall arrange with the water utility for any taps for disinfection by chlorination.
- C. Provide copies of test results to Owner's Representative and the water utility

3.7 SERVICE CONNECTIONS

- A. Provide water service to utility company requirements with vault, double check backflow preventer and valves as indicated on drawings.

3.8 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Compaction testing will be performed in accordance with ANSI/ASTM D698.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION 33 11 00

SECTION 333000 – SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Included:

1. Sanitary sewerage drainage piping, fittings, accessories and bedding.
2. Connection of building sanitary sewerage system to municipal sewers.
3. Manholes, Cleanouts.

B. Related Sections include:

1. Section 310000 – Earthwork
2. Section 312319 – Dewatering
3. Section 315000 – Excavation

1.3 REFERENCES

- A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.
- B. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb Rammer and 12" Drop.
- C. ASTM C700 – Vitrified clay pipe, extra strength, standard strength and perforated.
- D. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb Rammer and 18" Drop.
- E. ANSI/ASTM D2321 - Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- F. ANSI/ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings, SDR 35 O-ring joint.
- G. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

- H. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

1.4 DEFINITIONS

- A. Bedding: Aggregate fill placed under and beside pipe, prior to subsequent backfill operations.

1.5 SUBMITTALS

- A. Product Data: Provide data indicating pipe, pipe accessories; manholes, cleanouts, frames and lids, steps.
- B. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.6 PROJECT RECORD DOCUMENTS

- A. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 REGULATORY REQUIREMENTS

- A. Conform to all applicable code for materials and installation of the Work of this section.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements and elevations are as indicated.

1.9 COORDINATION

- A. Coordinate the Work with termination of sanitary sewer termination point outside building, connection to municipal sewer utility service, and trenching.

PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS

- A. Plastic Pipe: ANSI/ASTM D3034, Type PSM, Polyvinyl Chloride (PVC) material; inside nominal diameter as indicated, bell and spigot style, O-ring joint end.

2.2 PIPE ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- C. Underground-Type Plastic Line Marker: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide green tape with black printing reading "CAUTION SEWER LINE BURIED BELOW".

2.3 BEDDING MATERIALS

- A. Bedding shall conform to ODOT CMS Class B; backfill material shall conform to 310000.

2.4 SANITARY SEWER MANHOLES

- A. General: Provide precast reinforced concrete sanitary manholes as indicated, and complying with ASTM C 478.
- B. Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated.
- C. Base: Precast concrete, with base riser section and separate base slab, or base riser section with integral floor, as indicated.
- D. Steps: Ductile-iron or aluminum, integrally cast into manhole sidewalls.
- E. Frame and Cover: Ductile-iron, heavy-duty, indented top design, with lettering cast into top reading "SANITARY SEWER", size and type as shown on drawings.
- F. Pipe Connectors: Resilient, complying with ASTM C 923.

2.5 CLEANOUTS

- A. General: Provide as indicated, pipe extension to grade with ferrule and countersunk cleanout plug. Provide round cast-iron access frame over cleanout, with heavy-duty secured scoriated cover with lifting device.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that trench cut and base excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.
- B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 310000 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 8" compacted depth, compacted in accordance with section 310000.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION – PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D2321 and manufacturer's instructions. Seal joints watertight.
- B. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8" in 10 feet.
- C. Install bedding at sides and over top of pipe to minimum compacted thickness of 12"; compacted in accordance with section 310000.
- D. Refer to Section 310000 for trenching requirements. Do not displace or damage pipe when compacting.
- E. Connect sanitary sewer outlet to municipal sewer system.
- F. Install trace wire continuous over top of pipe. Coordinate with Section 312000.

3.5 INSTALLATION – MANHOLES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.
- E. Place precast concrete sections as indicated. Where manholes occur in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops 3" above finish surface, unless otherwise indicated.

- F. Install in accordance with ASTM C 891.
- G. Provide rubber joint gasket complying with ASTM C 443 at joints of sections.

3.6 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Request inspection prior to and immediately after placing bedding.
- C. Compaction testing will be performed in accordance with ANSI/ASTM D698.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- E. Pressure Test: Test in accordance with requirements of local authority.
- F. Infiltration Test: Test in accordance with requirements of local authority.
- G. Deflection Test: Test in accordance with requirements of local authority.

3.7 PROTECTION

- A. Protect finished installation under provisions of Division 1.
- B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 30 00

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SECTION 334000 – STORM DRAINAGE UTILITIES

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. The work of this section shall include all construction of entire storm sewer system and storm water detention system including connections between the storm water system and the leaders to the building storm water down spouts, yard drains, drain tile and associated underground piping.
- B. Related Sections include:
 - 1. Section 310000 – Earthwork
 - 2. Section 312319 – Dewatering
 - 3. Section 315000 – Excavation

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for drainage materials and products.
- C. Shop Drawings showing pipe sizes, special fittings, attachments, manholes, catch basins, castings, grates, underdrains, etc. Include details of underground detention structure, connections and special piping shapes and sizes as shown on the Contract Drawings.

1.4 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to storm sewerage systems.
- B. Utility Compliance: Comply with local utility regulations and standards pertaining to storm water sewerage systems. Catch basins, manholes and inlets shall be installed in accordance with the plans, and shall be installed to proper plan elevation $\pm 1/2$ inch.

1.5 PROJECT CONDITIONS.

- A. Site Information: Verify existing utility locations and depths prior to starting work. Verify that storm sewerage system piping may be installed in compliance with reference standards.
- B. Prior to installing run of pipes determine that existing utility lines have been removed.
- C. Coordinate the work of this section with other site preparation work, such as tree clearing and earthwork.

PART 2 - PRODUCTS

2.1 CORRUGATED HIGH DENSITY POLYETHYLENE PIPE

- A. Pipe manufactured for this specification shall comply with the requirements for test methods, dimensions, and markings found in AASHTO M252 Type S for 4" – 10" diameters or AASHTO M294 Type S for 12" – 60" diameters. As further defined and described in AASHTO M252 and AASHTO M294, the prescribed sizes of pipe are nominal inside diameters. Pipe diameter tolerance shall be 4.5 percent oversize and 1.5 percent undersize. Pipe lengths shall not be less than 99 percent of the manufactures stated length.
- B. Four- through 10-inch (100 through 250 mm) pipe shall be silt tight and shall be Hancor Sure-Lok F477 or pre-approved equal. Pipe supplied shall be smooth Interior and Annular Exterior Corrugated High Density Polyethylene (HDPE) Pipe meeting the requirements of AASHTO M252, Type S. The pipe supplied shall be silt tight as defined in the joint performance requirements of this specification.
- C. Twelve- through 60-inch (300 through 1500 mm) pipe shall be silt tight and shall be Hancor Sure-Lok F477 or pre-approved equal. Pipe supplied shall be smooth Interior and Annular Exterior Corrugated High Density Polyethylene (HDPE) Pipe meeting the requirements of AASHTO M294, Type S. The pipe supplied shall be silt tight as defined in the joint performance requirements of this specification.
- D. Virgin material for 4"- 10" Pipe and fitting production shall meet the requirements of AASHTO M252.
- E. Virgin material for 12"- 60" Pipe and fitting production shall meet the requirements of AASHTO M294 with the addition that it shall be a slow crack resistant material evaluated using the notched constant ligament-stress (NCLS) test according to the procedure described in AASHTO M294, Section 9.5. Average NCLS test specimens must exceed 24 hours with no test results less than 17 hours. The virgin material shall have a minimum 50-year tensile strength of 900 psi.
- F. Joint Performance
 - 1. Silt tight joints shall be bell-and-spigot meeting the silt tight requirements of AASHTO M252 or AASHTO M294. Silt tight joints shall meet a 2.0 psi (14kPa) laboratory test as further defined and described in the performance section of this specification. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the

gasket is free from debris. A joint lubricant supplied by the pipe manufacturer shall be used on the gasket and bell during assembly.

G. Fittings

1. Fittings shall conform to AASHTO M252 or AASHTO M294. Fabricated fittings shall be welded on the interior and exterior at all accessible junctions.

H. Acceptable Manufacturers

1. Manufacturer shall submit production lot testing logs, signed by an executive officer, to verify adequate quality assurance quality control system. In lieu of test logs, manufacturer shall have an ISO 9001:2000 Quality Lab and a quality control – quality assurance system based on ISO 9001:2000 standards and manufacturer shall be UL listed for quality systems on the ISO 9001:2000 quality systems certification.

I. Installation

1. Pipe installation shall be in accordance with Section 3 of this specification and the product manufacturer's published installation guides.

2.2 CATCH BASINS

A. Standard Precast Concrete Catch Basins and Manholes

1. Standard Precast Concrete Catch Basins shall meet ASTM C478/C478M, and shall be manufactured with precast reinforced concrete. Minimum diameter shall be 48-inch or 24" x 24" square.
 - a. Base section shall have a minimum floor slab thickness of 6 inches and shall have a minimum wall thickness of 4 inches. Wall and floor thickness of base section shall be as specified on project plans.
 - b. Riser Sections shall have a minimum wall thickness of 4 inches and a minimum diameter of 48 inches. Lengths and depths shall be as specified on project plans.
 - c. Top section shall consist of eccentric-cone type unless concentric-cone or flat-slab-top type is specified on project plans.
 - d. Joint Sealant shall meet ASTM C990/C990M and shall be manufactured with bitumen or butyl rubber.
 - e. As specified on project plans, reinforced concrete grade rings shall be used to adjust final grate elevation. Inside diameter of grade rings shall be same as inside diameter of top section.
 - f. Steps shall consist of individual FRP steps, FRP ladder, or 1/2-inch steel reinforcing rods meeting ASTM A615/A615M encased in polypropylene meeting ASTM D4101. Steps shall be wide enough to allow worker to place both feet on one (1) step and designed to prevent lateral slippage off step. Steps shall be cast or anchored into sidewalls at 12- to 16-inch intervals. Steps shall be omitted if total depth from floor of catch basin to finished grade is less than 60 inches.
 - g. Pipe connectors shall meet ASTM C923/C923M, shall be resilient and shall be sized for each pipe connecting to base section. Pipe connectors shall be fitted or cast into manhole walls.

- h. Steps shall be installed in the manhole such that the worker will face on coming vehicular traffic.

B. Designed Precast Concrete Catch Basins and Manholes

1. Designed precast concrete catch basins shall meet ASTM C913 and shall be designed according to ASTM C890 for AASHTO HS-25, heavy-traffic, structural loading.
 - a. Joint sealant shall meet ASTM C990/C990M and shall be manufactured with bitumen or butyl rubber.
 - b. As specified on project plans, reinforced concrete grade rings shall be used to adjust final grate elevation. Inside diameter of grade rings shall be same as inside diameter of top of top section.
 - c. Steps shall consist of individual FRP steps, FRP ladder, or 1/2-inch steel reinforcing rods meeting ASTM A615/A615M encased in polypropylene meeting ASTM D4101. Steps shall be wide enough to allow worker to place both feet on one (1) step and designed to prevent lateral slippage off step. Steps shall be cast or anchored into sidewalls at 12- to 16-inch intervals. Steps shall be omitted if total depth from floor of catch basin to finished grade is less than 60 inches.
 - d. Pipe connectors shall meet ASTM C923/C923M, shall be resilient and shall be sized for each pipe connecting to base section. Pipe connectors shall be fitted or cast into manhole walls.
2. Catch Basin Frame and Grates
 - a. Frames and grates shall be manufactured with grade 80-55-06 ductile iron meeting ASTM A536 as specified on project plans. Frames and grates shall be designed to accept H-25 and HS-25 live loads with a concrete collar installed under the frame.
 - b. Grates shall be bicycle safe.

2.3 DRAIN TILE

A. Plastic Pipe

1. ANSI/ASTM D2751, SDR 35, Acrylonitrile-Butadiene-Styrene (ABS) material; inside nominal diameter of 4 inches, bell and spigot style solvent sealed joint end.
2. Fittings shall be same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling shall be as specified in Division 3 Section 310000 "Earthwork." Embankment and fill shall be compacted in place prior to trenching.

3.2 IDENTIFICATION

- A. For all stormwater and subsurface drainage piping, install green warning tape directly over pipe and at outside edges of underground structures.
 - 1. Green warning tape or detectable warning tape shall be installed over ferrous piping.
 - 2. Detectable warning tape shall be installed over nonferrous piping and over edges of underground structures

3.3 PIPE INSPECTION

- A. General
 - 1. Piping, fittings, and drainage structures shall be inspected prior to installation and any defective or damaged product shall be replaced.
 - 2. All pipe shall be in new condition.
- B. Corrugated HDPE Pipe and Fittings
 - 1. Any pipe, fittings, or drainage structures with cuts, punctures, or other damage on the interior or exterior shall be rejected and replaced.
 - 2. Any pipe, fittings or drainage structures with damaged ends or joints, which would prevent proper sealing of the joints, shall be rejected and replaced.

3.4 PIPING, FITTING, AND DRAINAGE STRUCTURE INSTALLATION

- A. General
 - 1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm and drainage piping system, when determining location and arrangement of piping layout in the field, consider field conditions. Install piping system as indicated herein and as directed by the product manufacturer, to extent practical. Where specific installation procedure is not indicated, follow product manufacturer's written instructions.
 - 2. All products shall be inspected for defects and cracks before being lowered into the trench, piece by piece. Any defective, damaged or unsound pipe, fitting or drainage structure or any product that has had its grade disturbed after laying, shall be taken up and replaced. Open ends shall be protected with a pipe plug to prevent earth or other material from entering the pipe during construction. The interior of the pipe shall be free from dirt, excess water and other foreign materials as the pipe laying progresses and left clean at the completion of the installation.
 - 3. Install piping system beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions. Follow product manufacturer's instructions for the use of lubricants, cements, and other special installation requirements.
 - 4. Use Manholes or Catch Basins for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
 - 5. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

B. Trench Excavation

1. Excavation

- a. Excavate trenches to ensure that sides will be stable under all working conditions. Slope trench walls or provide supports in conformance with all local and national standards for safety. Open only as much trench as can be safely maintained by available equipment. Backfill all trenches as soon as practicable, but not later than the end of each working day.
- b. Where trench walls are stable or supported, provide a width sufficient, but no greater than necessary, to ensure working room to properly and safely place and compact haunching and other embedment materials. The space between the pipe and trench wall must be wider than the compaction equipment used in the pipe zone. Minimum width shall be not less than the greater of either the pipe outside diameter plus 16 in. or the pipe outside diameter times 1.25, plus 12 in. In addition to safety considerations, trench width in unsupported, unstable soils will depend on the size and stiffness of the pipe, stiffness of the embedment and in-situ soil, and depth of cover.
- c. When supports such as trench sheeting, trench jacks, trench shields or boxes are used, ensure that support of the pipe and its embedment is maintained throughout installation. Ensure that sheeting is sufficiently tight to prevent washing out of the trench wall from behind the sheeting. Provide tight support of trench walls below viaducts, existing utilities, or other obstructions that restrict driving of sheeting.

2. Dewatering

- a. Do not lay or embed pipe fittings or drainage structures in standing or running water. At all times, prevent runoff and surface water from entering the trench.
- b. When water is present in the work area, dewater to maintain stability of in-situ and imported materials. Maintain water level below pipe bedding and foundation to provide a stable trench bottom. Use, as appropriate, sump pumps, well points, deep wells, geofabrics, perforated under drains, or stone blankets of sufficient thickness to remove and control water in the trench. When excavating while depressing ground water, ensure the ground water is below the bottom of cut at all times to prevent washout from behind sheeting or sloughing of exposed trench walls. Maintain control of water in the trench before, during, and after pipe system installation and until embedment is installed and sufficient backfill has been placed to prevent flotation of the pipe, fitting, or drainage structures. To preclude loss of soil support, employ dewatering methods that minimize removal of fines and the creation of voids in in-situ materials.

3. Removal of Rock

- a. Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between exposed rock and the pipe of at least 12 inches (0.3m). Where Bell-and-Spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined under section 02300 Earthwork.

4. Removal of Unstable Material

- a. Where wet or otherwise unstable soil incapable of properly supporting the pipe system, as determined by the Engineer, is encountered in the bottom of a trench,

such material shall be removed to at least 24 inches below bottom of pipe and replaced to the proper grade with select granular material, compacted as directed by the engineer. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Owner.

5. Bedding

- a. Stable and uniform bedding shall be provided for the pipe and any protruding features of its joint and/or fittings. The middle of the bedding, equal to one-third of the pipe outside diameter, shall be loosely placed while the remainder shall be compacted to a minimum of 90% of maximum density per AASHTO T99, or as shown in the plans. Pipe bedding shall be a minimum of 4" – 6" in thickness. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

6. Placing Pipe

- a. Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Pipe shall not be laid in water, and the pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches shall be provided as directed by the engineer; see dewatering section.

7. Jointing

- a. Joints shall be constructed as described herein and in accordance with manufacturer's installation instructions.
- b. All Bell-and-Spigot pipe joints shall be thoroughly cleaned. Joint lubricant, supplied by the manufacturer, shall be liberally applied to entire interior of bell and gasket on spigot prior to assembly.

8. Backfilling

a. General

- 1) Backfill material, placement, and compaction shall be constructed in accordance with the specifications herein and the product manufacturer's published installation guides.

b. Backfilling Pipe in Trenches

- 1) After the pipe and pipe system have been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layer depths to ensure minimum compaction density is obtained evenly throughout the backfill material. The backfill shall be brought up evenly on both sides of pipe and pipe system for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by

mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Engineer, that sheeting or portions of bracing used may be left in place. Untreated sheeting shall not be left in place beneath structures or pavements.

c. Backfilling Pipe in Fill Sections

- 1) For pipe placed in fill sections, fill shall be constructed to at least 12 inches above the top of proposed pipe prior to trench excavation. Fill shall be placed in 12-inch lifts and shall be compacted in accordance with section 310000. Once fill is placed and compacted pipe trench shall be constructed in accordance with the Trench Excavation section of this specification.

d. Movement of Construction Machinery

- 1) When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

e. Compaction

- 1) General Requirements

- a) Non-cohesive materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, non-cohesive soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

- 2) Minimum Density

- a) Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.
- b) Under paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, all trench backfill shall be compacted #57 crushed aggregate up to the subgrade elevation. Recycled concrete or asphalt material is not acceptable for use.

- 3) Determination of Density

- a) Testing shall be the responsibility of the Contractor and performed at no additional cost to the Owner. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval by the Engineer. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers shall be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with

ASTM D2167 or ASTM D2922. When ASTM D2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in the Calibration paragraph of the referenced publications. ASTM D2922 results in a wet unit weight of soil and when using this method ASTM D3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D3017 or ASTM D2922. Test results shall be furnished to the Engineer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.5 MANHOLE AND CATCH BASIN INSTALLATION

- A. In addition to the piping, fitting, and drainage structure installation specifications, the following shall be considered for the installation of manholes and catch basins.
 - 1. Manholes and catch basins shall be installed according to the manufacturer's written instructions.
 - 2. Manholes and catch basins shall be installed complete with appurtenances and accessories indicated on the project plans.
 - 3. Precast concrete manhole and catch basin sections shall be installed with gaskets according to ASTM C891.
 - 4. Cast in place manholes shall be constructed as indicated on the project plans.
 - 5. Tops of frames and covers shall be set flush with finished surface of manholes in paved areas.

3.6 FINAL INSPECTION

- A. Upon completion of the work and before final acceptance by the Owner, the entire drainage system shall be subject to a final inspection in the presence of the Owner and Architect. The work shall not be considered as complete until all requirements for line, grade, cleanliness, and workmanship have been completed. The contractor shall provide an as-built survey of the storm sewer systems.

END OF SECTION 33 40 00

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SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipe and fittings.
2. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Drainage conduits, including rated capacities.
2. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for loose joints.

2.2 SOIL MATERIALS

- A. Soil materials are specified in Section 312000 "Earth Moving."

2.3 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
 1. Styles: Flat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 RETAINING-WALL DRAINAGE INSTALLATION

- A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 2 inches.
- C. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- D. Place drainage course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- E. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.4 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width as indicated. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 2 inches.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls.
- E. Add drainage course to top of drainage conduits.

- F. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- G. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.5 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 - 1. Lay perforated pipe with perforations down.
 - 2. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

3.6 PIPE JOINT CONSTRUCTION

- A. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

3.8 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."
 - 1. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
 - 2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600.