

PROJECT MANUAL
PERMIT SET
VOLUME 2 OF 2

JOHN KNOX VILLAGE -
MEADOWS BUILDING
PHASE II



Lee's Summit, Missouri



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Commission No. 19132.00

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DIVISION 11
EQUIPMENT

SECTION 113100 - RESIDENTIAL APPLIANCES

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. Cooking appliances.
 - 2. Kitchen exhaust ventilation.
 - 3. Refrigeration appliances.
 - 4. Cleaning appliances.

1.3 ALLOWANCES

- A. Furnish residential appliances as part of residential appliance allowance.
- B. Furnish clothes washer and dryer, as part of residential appliance allowance.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, dimensions, furnished accessories, and finishes for each appliance.
- B. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.
- C. Product Schedule: For appliances. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified manufacturer.
- B. Product Certificates: For each type of appliance, from manufacturer.
- C. Field quality-control reports.
- D. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintains, within 25 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- B. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.
- C. Source Limitations: Obtain residential appliances from single source and each type of residential appliance from single manufacturer.
- D. Regulatory Requirements: Comply with the following:
 - 1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.
- E. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
- F. Preinstallation Conference: Conduct conference at Project site.

1.8 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Electric Cooktop Range: Full warranty including parts and labor for on-site service on surface-burner elements.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- C. Microwave Oven: Full warranty including parts and labor for on-site service.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- D. Refrigerator/Freezer Icemaker, Sealed System: Full warranty including parts and labor for on-site service on the product.
 - 1. Warranty Period for Sealed Refrigeration System: Two years from date of Substantial Completion.

2. Warranty Period for Other Components: Two years from date of Substantial Completion.
- E. Dishwasher: Full warranty including parts and labor for on-site service on the product.
 1. Warranty Period for Deterioration of Tub and Metal Door Liner: Five years from date of Substantial Completion.
 2. Warranty Period for Other Components: Two years from date of Substantial Completion.
- F. Clothes Washer / Dryer: Full warranty including parts and labor for on-site service on the product.
 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS -

2.1 ELECTRIC COOKTOP

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. GE Appliances
- B. Electric Range: Slide-in range with one oven(s) and complying with AHAM ER-1.
 1. Basis-of-Design Product: GE 30" Built-In Knob Control Electric Cooktop, model #JP3030SJSS
 2. Width: 30 inches.
 3. Electric Burner Elements: Four.
 - a. Radiant Type: two 2500W and two 1200W.
 - b. Controls: Knob
 - c. Radiant Smoothtop
 4. Electric Power Supply: 240 V, 60 Hz, 1 phase, 40 A.
 5. Material: Black with ceramic-glass cooktop with Stainless Steel Trim

2.2 SINGLE WALL OVEN

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. GE Appliances
- B. Single Wall Oven:
 1. Basis-of-Design Product: GE Smart Built-In Self-Clean Single Wall Oven, model # JTS3000SNSS
 2. Width: 30 inches.
 3. Capacity: 5.0 cu ft
 4. Operation: Baking and self clean
 5. Broiler: 4000 w
 6. Controls: Electronic Glass Touch Controls

7. Electric Power Supply: 240 V, 60 Hz, 1 phase, 20A.
8. Material: Black with ceramic-glass cooktop with Stainless Steel Trim

2.3 MICROWAVE OVENS

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

1. GE Appliances

B. Microwave Oven:

1. Basis-of-Design Product: GE 2.2 Cu Ft Countertop Sensor, model # PES7227SLSS
2. Mounting: Countertop
3. Type: Conventional.
4. Dimensions:
 - a. Width: 24 1/8 inches.
 - b. Depth: 19 3/4 inches with handle.
 - c. Height: 14 inches.
5. Capacity: 2.2 cu. ft.
6. Oven Door: Door with observation window and pull handle.
7. Exhaust Fan: Variable-speed fan, nonvented, recirculating type with charcoal filter and with manufacturer's standard capacity.
8. Microwave Power Rating: 1580 W.
9. Electric Power Supply: 120 V, 60 Hz, 1 phase, 15 A.
10. Controls: Digital panel controls and timer display.
11. Material: Stainless Steel

2.4 KITCHEN EXHAUST VENTILATION

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

1. GE Appliances

B. Overhead Exhaust Hood:

1. Basis-of-Design Product: GE 30 Under the Cabinet Hood, #JVX3300SJSS
2. Type: Wall mounted exhaust-hood system.
3. Dimensions:
 - a. Width: 30 inches.
 - b. Depth: 20 inches.
4. Exhaust Fan: Variable-speed fan built into hood and with manufacturer's standard 180 cfm capacity.
 - a. Venting: Nonvented, recirculating type with charcoal filter.
 - b. Fan Control: Hood-mounted fan switch, with separate hood-light control switch.

5. Duct Type: Manufacturer's standard.
6. Finish: Stainless Steel
7. Features:
 - a. Permanent, washable aluminum mesh filter(s).
 - b. Built-in incandescent lighting.
 - c. Warming lamp socket(s).

2.5 REFRIGERATOR/FREEZERS

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

1. GE Appliances

B. Refrigerator/Freezer: Side by Side Refrigerator and complying with AHAM HRF-1.

1. Basis-of-Design Product: GE 23.2 Cu Ft, model # GSS23HSHSS
2. Type: Freestanding.
3. Dimensions:
 - a. Width: 32 3/4 inches.
 - b. Depth: 35 1/4 inches.
 - c. Height: 69 1/2 inches.
4. Storage Capacity:
 - a. Refrigeration Compartment Volume: 16.23 cu ft.
 - b. Freezer Volume: 6.94 cu. ft.
5. General Features:
 - a. Door Configuration: Overlay.
 - b. Dual refrigeration systems.
 - c. Separate temperature controls for each compartment.
 - d. Factory installed ice maker
6. Refrigerator Features:
 - a. Interior light in refrigeration compartment.
 - b. Fresh food compartments.
 - c. Snack drawer.
 - d. Door Storage: Yes.
 - e. Door Water/Ice Dispenser
7. Freezer Features: Two freezer compartment(s) configured as pull-out drawer(s).
 - a. Frost Free.
 - b. Interior light in freezer compartment.
 - c. Automatic icemaker and storage bin.

8. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
9. Front Panel(s): Stainless Steel
10. Appliance Color/Finish: Stainless Steel

C. Refrigerator/Freezer: Counter-depth Side-By-Side and complying with AHAM HRF-1.

1. Basis-of-Design Product: GE 21.9 Cu Ft Counter-Depth Side-By-Side Refrigerator, Model # GZS22DSJSS
2. Type: Freestanding.
3. Dimensions:
 - a. Width: 35 3/4 inches.
 - b. Depth: 29 1/2 inches.
 - c. Height: 69 1/4 inches.
4. Storage Capacity:
 - a. Refrigeration Compartment Volume: 14.08 cu ft.
 - b. Freezer Volume: 7.79 cu. ft.
5. General Features:
 - a. Door Configuration: Overlay.
 - b. Dual refrigeration systems.
 - c. Separate temperature controls for each compartment.
 - d. Include optional ice maker. (IM4D Ready)
6. Refrigerator Features:
 - a. Interior light in refrigeration compartment.
 - b. Fresh food compartments.
 - c. Snack drawer.
 - d. Door Storage: Yes.
7. Freezer Features: Two freezer compartment(s) configured as pull-out drawer(s).
 - a. Frost Guard.
 - b. Interior light in freezer compartment.
 - c. Two-level freezer baskets.
8. Front Panel(s): Stainless Steel
9. Appliance Color/Finish: Stainless Steel

2.6 DISHWASHERS

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

1. GE Appliances
- B. Dishwasher: Complying with AHAM DW-1 and ASSE 1006.
1. Basis-of-Design Product: GE model number GDF645SSNSS
 2. Type: Built-in undercounter
 3. Dimensions:
 - a. Width: 23 3/4 inches.
 - b. Depth: 24 inches.
 - c. Height: 34 inches.
 4. Capacity:
 - a. Place Settings of China: Sixteen.
 5. Sound Level: Maximum 55 dB.
 6. Tub and Door Liner: Manufacturer's standard Stainless steel with sealed detergent and automatic rinsing-aid dispensers.
 7. Rack System: Nylon-coated sliding dish racks, with removable cutlery basket.
 8. Controls: Touch-pad controls with four wash cycles and hot-air and heat-off drying cycle options.
 9. Features:
 - a. Waste food disposer.
 - b. Self-cleaning food-filter system.
 - c. Hot-water booster heater for 140 deg F wash water with incoming water at 100 deg F.
 - d. Lock-out feature.
 - e. Half-load option.
 - f. Delay-wash option.
 - g. Digital display panel.
 - h. Water softener.
 - i. Soil-sensing water use control system.
 10. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
 11. Front Panel: Black Metal.
 12. Appliance Color/Finish: Stainless Steel
- C. Dishwasher: Complying with AHAM DW-1 and ASSE 1006.
1. Basis-of-Design Product: GE model number GLDA696FSS
 2. Type: Built-in undercounter
 3. Dimensions:
 - a. Width: 24 inches.
 - b. Depth: 24 inches.
 - c. Height: 32-11/32 inches.

4. Capacity:
 - a. Place Settings of China: Twelve
5. Sound Level: Maximum 56 dB.
6. Tub and Door Liner: Manufacturer's standard Stainless steel with sealed detergent and automatic rinsing-aid dispensers.
7. Controls: Electronic, 9 touchpads and front controls.
8. Features:
 - a. 2-digit countdown display
 - b. Electronic controls with 4 cycles/4 options
 - c. 2 utility shelves in tiered upper rack with 1 Stem Safe
 - d. Deluxe lower rack
 - e. Pots and pans cycle
 - f. Heated dry option
9. Front Panel: Black Metal.
10. Appliance Color/Finish: Black Metal.

2.7 WASHER AND DRYER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. GE Appliances
- B. Clothes Washer: Complying with ASSE 1007.
 1. Basis-of-Design Product: GE 4.8 Cu Ft Capacity Frontload Washer # GFW5500SSNWW
 2. Type: Side
 3. Dimensions:
 - a. Width: 28 inches.
 - b. Depth: 32 inches.
 - c. Height: 39 3/4 inches.
 4. Washer Drum: Perforated stainless steel.
 5. Controls: Digital cycle countdown, LED indicators, control lock and end-of-cycle signal.
 - a. Wash Cycles: Ten wash cycles including whites, colors/normal, NSF sanitize, delicates/hand was, speed wash, drain and spin, bulky/bedding, towels and sheets and basket clean.
 - b. Wash Temperatures: Five with Sanitize
 - c. Speed Combinations: Five.
 6. Electrical Power: 120 V, 60 Hz, 1 phase, 15 A.

7. Motor: Variable 1300 RPM max spin speed
8. Washer Features:
 - a. Internal water heater
 - b. Sanitize cycle
 - c. Speed wash
 - d. Vibration control
 - e. Automatic dispenser for bleach fabric softener and detergent.
 - f. Digital cycle countdown
 - g. LED indicators
 - h. Control lock
 - i. Adjustable leveling legs
 - j. Variable 1100 RPM spin speed
 - k. 3-Prong Grounding
9. Appliance Finish: Porcelain enamel on top and lid; baked enamel on front and sides.
 - a. Color: White.
10. Front-Panel Finish: Porcelain enamel.
 - a. Panel Color: White.

C. Clothes Dryer: Complying with ASSE 1007.

1. Basis-of-Design Product: GE 7.8 Cu Ft. Capacity Electric Dryer, model # GFD55ESSNWW
2. Type: Side
3. Dimensions:
 - a. Width: 28 inches.
 - b. Depth: 32 inches.
 - c. Height: 39 3/4 inches.
4. Washer Drum: Perforated stainless steel.
5. Controls: Rotary-Electronic with LEDs
 - a. Dry Cycles: Ten, including delicates
 - b. Dry Temperatures: Five heat selections.
 - c. Dryness Levels: Four.
6. Electrical Power: 120 V, 60 Hz, 1 phase, 24 A.
7. Motor: Manufacturer's standard with built-in overload protector.
8. Dryer Features:
 - a. Timed Dry
 - b. Tumble Dry

- c. Cottons Cycle
 - d. Removable up-front lint filter
 - e. Drum type: Dura Drum
 - f. 4-Way exhaust option
 - g. Flexible installation
 - h. Reversible door
- 9. Appliance Finish: Porcelain enamel on top and lid; baked enamel on front and sides.
 - a. Color: White.
- 10. Front-Panel Finish: Porcelain enamel.
 - a. Panel Color: White.
- D. Pedestal Upgrade Option
 - 1. Basis of Design Product: GE GFP1528SNWW

2.8 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
- C. Examine walls, ceilings, and roofs for suitable conditions where overhead exhaust hoods and microwave ovens with vented exhaust fans will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Comply with manufacturer's written instructions.
- B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- D. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.
- E. Utilities: Comply with plumbing and electrical requirements.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After installation, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
- C. An appliance will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 DEMONSTRATION

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

END OF SECTION 113100

DIVISION 12
FURNISHINGS

SECTION 122113 - HORIZONTAL LOUVER BLINDS

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. Horizontal louver blinds with faux wood slats. – All Independent Living Windows
 - 2. Horizontal louver plantation shutters – All Commons Windows

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details for horizontal louver blinds.
- C. Samples for Initial Selection: For each type and color of horizontal louver blind.
 - 1. Include similar Samples of accessories involving color selection.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of horizontal louver blind.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For horizontal louver blinds to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Horizontal Louver Blinds: Full-size units equal to 5 percent of quantity installed for each size, color, texture, pattern, and gloss indicated, but no fewer than two units.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain horizontal louver blinds from single source from single manufacturer.

2.2 HORIZONTAL LOUVER BLINDS, FAUX WOOD SLATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Basis of Design: Graber – Lake Forest – 2” Faux Wood Blinds
 - 2. Hunter Douglas Contract.
 - 3. Levolor Contract; a Newell Rubbermaid company.
 - 4. Springs Window Fashions.
- B. Slats: PVC
 - 1. Width: 2 inch flat.
 - 2. Thickness: Not less than 0.10 inch .
 - 3. Spacing: Manufacturer's standard.
- C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.
 - 1. Capacity: One blind per headrail unless otherwise indicated.
 - 2. Ends: Capped or plugged .
 - 3. Manual Lift Mechanism:
 - a. Lift-Cord Lock: Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches long.

- b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.
 - 4. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
 - a. Tilt: Two-direction, positive stop or lockout limited at an angle of 60
 - b. Operator: Clear-plastic wand.
 - c. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.
 - 5. Manual Lift-Operator and Tilt-Operator Lengths: Full length of blind when blind is fully closed.
 - 6. Manual Lift-Operator and Tilt-Operator Locations: Manufacturer's standard unless otherwise indicated.
- D. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.
 - 1. Type: Top contoured to match crowned shape of slat and bottom contoured to minimize light gaps .
- E. Lift Cords: Manufacturer's standard braided cord.
- F. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.
 - 1. Type: Braided cord.
- G. Valance: Manufacturer's standard.
- H. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.
 - 1. Type: Wall.
 - 2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by blind manufacturer for weight and size of blind.
- I. Colors, Textures, Patterns, and Gloss:
 - 1. Slats: As selected by Architect from manufacturer's full range.
 - 2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

2.3 HORIZONTAL PLANTATION SHUTTERS,WOOD SLATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Basis of Design: Graber Traditions Wood Shutters
 - 2. Hunter Douglas Contract.
 - 3. Levolor Contract; a Newell Rubbermaid company.

4. Springs Window Fashions.

B. Slats: Wood

1. Width: 2 inch flat.
2. Thickness: Not less than 0.10 inch .
3. Spacing: Manufacturer's standard.

C. Colors, Textures, Patterns, and Gloss:

1. Slats: As selected by Architect from manufacturer's full range .
2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated .

2.4 HORIZONTAL LOUVER BLIND FABRICATION

A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F :

1. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.

D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind placement indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

2.5 HORIZONTAL LOUVER BLIND FABRICATION

A. Product Safety Standard: Fabricate horizontal wood shutters to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F :

1. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 1. Tilt Mechanisms: With permanently lubricated moving parts.
- D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of shutter without damaging blind and adjacent surfaces, for supporting shutter components, and for bracket positions and blind placement indicated.
- E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.
 1. Locate so exterior slat edges are not closer than 2 inches from interior faces of glass and not closer than 1-1/2 inches from interior faces of glazing frames through full operating ranges of blinds.
 2. Install mounting and intermediate brackets to prevent deflection of headrails.
 3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

- A. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer and that ensures that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

END OF SECTION 122113

SECTION 123530 - RESIDENTIAL CASEWORK

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 kitchen and vanity cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Cabinets.
 - 2. Cabinet hardware.
- B. Shop Drawings: Include plans, elevations, details, and attachments to other work. Show materials, finishes, filler panels, and hardware.
- C. Samples: For cabinet finishes.
- D. Samples for Initial Selection: For cabinet finishes.
- E. Samples for Verification: 8-by-10-inch Samples for each type of finish.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For casework.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete and dry, and temporary HVAC system is operating and maintaining temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Provide fillers and scribes to allow for trimming and fitting.

- C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

1.6 COORDINATION

- A. Coordinate layout and installation of blocking and reinforcement in partitions for support of casework.

PART 2 - PRODUCTS

2.1 CABINETS

- A. Basis of Design: Subject to the requirements, provide Products from Smart Cabinets
- B. Quality Standard: Provide cabinets that comply with KCMA A161.1.
 - 1. KCMA Certification: Provide cabinets with KCMA's "Certified Cabinet" seal affixed in a semiexposed location of each unit and showing compliance with the above standard.
- C. Cabinet Style: Face frame.
- D. Exposed Cabinet End Finish: Thermoformed-vinyl-faced panels.
- E. Factory Finishing: Finish cabinets at factory. Defer only final touchup until after installation.

2.2 CABINET MATERIALS

- A. General:
 - 1. Manufacturer's standard materials for this line of cabinets.
- B. Concealed Materials: Solid wood or plywood, of any hardwood or softwood species, with no defects affecting strength or utility; particleboard; MDF; or hardboard.

2.3 CABINET HARDWARE

- A. General: Manufacturer's standard units complying with BHMA A156.9, of type, size, style, material, and finish as selected by Architect from manufacturer's full range.
- B. Pulls: Wire pulls.
- C. Hinges: Semiconcealed (wraparound) butt hinges for overlay doors.
- D. Drawer Guides: Epoxy-coated-metal, self-closing drawer guides; designed to prevent rebound when drawers are closed; with nylon-tired, ball-bearing rollers; and complying with BHMA A156.9, Type B05011 or Type B05091.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of casework.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinets with no variations in flushness of adjoining surfaces; use concealed shims. Where cabinets abut other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match cabinet face.
- B. Install cabinets without distortion so doors and drawers fit the openings, are aligned, and are uniformly spaced. Complete installation of hardware and accessories as indicated.
- C. Install cabinets level and plumb to a tolerance of 1/8 inch in 8 feet.
- D. Fasten cabinets to adjacent units and to backing.
 - 1. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips or No. 10 wafer-head sheet metal screws through the metal backing or metal framing behind the wall finish.
- E. Install hardware.

3.3 ADJUSTING AND CLEANING

- A. Adjust cabinets and hardware so doors and drawers are centered in openings and operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
- B. Clean casework on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 123530

SECTION 123640 - STONE COUNTERTOPS

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 stone countertops.

1.3 ACTION SUBMITTALS

- A. Product Data: For each variety of stone, stone accessory, and manufactured product.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work.
 - 1. Show locations and details of joints.
 - 2. Show direction of veining, grain, or other directional pattern.
- C. Samples for Verification:
 - 1. For each stone type indicated, in sets of Samples not less than 12 inches square. Include two or more Samples in each set and show the full range of variations in appearance characteristics expected in completed Work.

1.4 INFORMATIONAL SUBMITTALS

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.
- B. The QCP Registration No.: 14.0499.
- C. Installer Qualifications: Fabricator of products and participant in AWI's Quality Certification Program.
- D. Qualification Data: For fabricator.
- E. Material Test Reports:
 - 1. Stone Test Reports: For each stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, according to referenced ASTM standards. Base reports on testing done within previous three years.
 - 2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For stone countertops to include in maintenance manuals. Include product data for stone-care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate stone countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of stone countertops.
- C. The QCP Registration No.: 14.0499.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
 - 1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
 - 2. Store stone on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of construction to receive stone countertops by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 STONE COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, installation, and other requirements.
 - 1. Provide labels and certificates from AWI certification program indicating that countertops, including installation, comply with requirements of grades specified.
 - 2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

2.2 MANUFACTURERS

- A. Source Limitations for Stone: Obtain each variety of stone specified in the Finish Schedule.

2.3 GRANITE

- A. Material Standard: Comply with ASTM C 615.
- B. Description: Uniform, as specified. See Finish Schedule.
- C. Cut: See Finish Schedule.
- D. Cut stone from contiguous, matched slabs in which natural markings occur.
- E. Finish: As indicated.

2.4 ADHESIVES, GROUT, SEALANTS, AND STONE ACCESSORIES

- A. General: Use only adhesives formulated for stone and ceramic tile and that are recommended by their manufacturer for the application indicated.
- B. Water-Cleanable Epoxy Adhesive: ANSI A118.3.
- C. Sealant for Countertops: Manufacturer's standard sealant of characteristics indicated below that will not stain the stone it is applied to.
 - 1. Mildew-Resistant Joint Sealant: Single component, nonsag, mildew resistant, acid curing, silicone.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Stone Cleaner: Specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer and, if a sealer is specified, by sealer manufacturer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.
- E. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

2.5 STONE FABRICATION, GENERAL

- A. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.
 - 1. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically displeasing, as judged by Architect.
- B. Grade and mark stone for final locations to produce assembled countertop units with an overall uniform appearance.
- C. Fabricate stone countertops in sizes and shapes required to comply with requirements indicated.
 - 1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
 - 2. Clean sawed backs of stones to remove rust stains and iron particles.
 - 3. Dress joints straight and at right angle to face unless otherwise indicated.

4. Cut and drill sinkages and holes in stone for anchors, supports, and attachments.
 5. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
 6. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile to produce uniform shape throughout entire length of edge and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units. Form corners of molded edges as indicated with outside corners slightly eased unless otherwise indicated.
 7. Finish exposed faces of stone to comply with requirements indicated for finish of each stone type required and to match approved Samples and mockups. Provide matching finish on exposed edges of countertops, splashes, and cutouts.
- D. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

2.6 STONE COUNTERTOPS

- A. Nominal Thickness: Provide thickness indicated, but not less than 3/4 inch. Gage backs to provide units of identical thickness.
- B. Edge Detail: As indicated.
- C. Splashes: Provide 3/4-inch-thick backsplashes and end splashes unless otherwise indicated.
1. Height: 4 inches unless indicated differently.
 2. Top-Edge Detail: As indicated.
- D. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated and as follows:
1. Sealant-Filled Joints: 1/16 inch in width.
- E. Cutouts and Holes:
1. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 2. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive stone countertops and conditions under which stone countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone countertops.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone countertops.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by stone countertop Installer for anchoring stone countertops. Furnish installers of other work with Drawings or templates showing locations of these items.
- B. Before installing stone countertops, clean dirty or stained stone surfaces by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives. Allow stone to dry before installing.

3.3 CONSTRUCTION TOLERANCES

- A. Variation from Level: Do not exceed 1/8 inch in 96 inches, 1/4 inch maximum.
- B. Variation in Joint Width: Do not vary joint thickness more than one-fourth of nominal joint width.
- C. Variation in Plane at Joints (Lipping): Do not exceed 1/64-inch difference between planes of adjacent units.
- D. Variation in Line of Edge at Joints (Lipping): Do not exceed 1/64-inch difference between edges of adjacent units, where edge line continues across joint.

3.4 INSTALLATION OF COUNTERTOPS

- A. General: Install countertops over plywood subtops with full spread of water-cleanable epoxy adhesive.
- B. Do not cut stone in field unless otherwise indicated. If stone countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.
- C. Set stone to comply with requirements indicated. Shim and adjust stone to locations indicated, with uniform joints of widths indicated and with edges and faces aligned according to

established relationships and indicated tolerances. Install anchors and other attachments indicated or necessary to secure stone countertops in place.

- D. Space joints with 1/16-inch gap for filling with grout. Use temporary shims to ensure uniform spacing.
 - 1. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- E. Install backsplashes and end splashes by adhering to wall with water-cleanable epoxy adhesive and to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- F. Grout joints to comply with ANSI A108.10. Remove temporary shims before grouting. Tool grout uniformly and smoothly with plastic tool.
- G. Apply sealant to joints and gaps specified for filling with sealant; comply with Section 079200 "Joint Sealants." Remove temporary shims before applying sealant.

3.5 ADJUSTING AND CLEANING

- A. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
- B. Remove and replace stone countertops of the following description:
 - 1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
 - 2. Defective countertops.
 - 3. Defective joints, including misaligned joints.
 - 4. Interior stone countertops and joints not matching approved Samples and mockups.
 - 5. Interior stone countertops not complying with other requirements indicated.
- C. Replace in a manner that results in stone countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.
- D. Clean stone countertops no fewer than six days after completion of installation, using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.
- E. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

END OF SECTION 123640

SECTION 123661 - SIMULATED STONE COUNTERTOPS

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. Cultured marble countertops and backsplashes.
 - 2. Quartz agglomerate countertops and backsplashes.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials and sinks.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches square.
 - 2. Wood trim, 8 inches long.
 - 3. One full-size cultured marble countertop, with front edge and backsplash, 8 by 10 inches, of construction and in configuration specified.
 - 4. One full-size quartz agglomerate countertop, with front edge and backsplash, 8 by 10 inches, of construction and in configuration specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Woodwork Quality Standard Compliance Certificates for quartz countertops: AWI Quality Certification Program certificates.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate stone countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of quartz countertops.
- C. The QCP Registration No.: 14.0499.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 CULTURED MARBLE COUNTERTOPS

- A. Configuration: Provide countertops with the following front and backsplash style:
 - 1. Front: As indicated.
 - 2. Backsplash: Coved, with 3/8-inch radius cove and top.
 - 3. Endsplash: Matching backsplash.
- B. Countertops: 1/2-inch- thick, cultured marble.
- C. Backsplashes: 1/2-inch- thick, cultured marble.
- D. Fabrication: Fabricate tops in one piece with integral sink bowls and backsplashes unless otherwise indicated.

2.2 QUARTZ AGGLOMERATE COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, installation, and other requirements.
 - 1. Provide labels and certificates from AWI certification program indicating that countertops, including installation, comply with requirements of grades specified.
 - 2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

- B. Configuration: Provide countertops with the following front and backsplash style:
 - 1. Front: As indicated.
 - 2. Backsplash: Straight, slightly eased at corner.
 - 3. Endsplash: Matching backsplash.
- C. Countertops: 3/4-inch- thick, quartz agglomerate with front edge built up with same material.
- D. Backsplashes: 3/4-inch- thick, quartz agglomerate.
- E. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.

2.3 COUNTERTOP MATERIALS

- A. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.
- B. Cultured Marble: Gel-coated solid fabrication of filled plastic resin complying with ANSI Z124.3, Type 4, with precoated finish, and not less than 1/2 inch thick.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bathroom World Manufacturing Company.
 - b. Cherry Marble Group.
 - c. Comar Products, Inc.
 - d. Craig Baker Marble Co., Inc.
 - e. Cultured Marble Products.
 - f. Custom Marble Products.
 - g. Imperial Marble Corp.
 - h. MarCraft, Inc.
 - i. Princess Marble.
 - j. Roma Marble, Inc.
 - k. Rynone Manufacturing Corp.
 - l. Tiffany Marble.
 - 2. Colors and Patterns: As selected by Architect from manufacturer's full range.
- C. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with the "Physical Characteristics of Materials" Article of ANSI S1.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cambria.

- b. Cosentino USA.
- c. E. I. du Pont de Nemours and Company.
- d. LG Chemical, Ltd.
- e. Meganite Inc.
- f. OKITE Quartz Surfacing by Seieffe Corporation.
- g. Samsung Chemical USA, Inc.
- h. Technistone USA, Inc.
- i. Transolid Div of Trumbull Industries.

- 2. Colors and Patterns: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 1. Install backsplashes and endsplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 2. Seal edges of cutouts in plywood subtops by saturating with varnish.

END OF SECTION 123661

DIVISION 14
CONVEYING EQUIPMENT

SECTION 142400 - HYDRAULIC ELEVATORS

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 hydraulic service elevators.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Hoist beams.
 - c. Structural-steel shapes for subsills.
 - d. Pit ladders.

1.3 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

1.4 ACTION SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control, and signal systems.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment.
 - 2. Include large-scale layout of car-control station.
 - 3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples for Initial Selection: For finishes involving color selection.
- D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch- square Samples of sheet materials; and 4-inch lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Kone
 - 2. Otis Elevator Company
 - 3. Schindler Group
 - 4. ThyssenKrupp
- B. Source Limitations: Obtain elevators from single manufacturer.
 - 1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
- C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and shall comply with elevator safety requirements for seismic risk Zone 3 or greater in ASME A17.1/CSA B44.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 - 2. Affected peak velocity acceleration (Av) for Project's location shall be calculated by the elevator manufacturer.
 - 3. Provide earthquake equipment required by ASME A17.1/CSA B44.
 - 4. Provide seismic switch required by ASCE/SEI 7.

5. Design earthquake spectral response acceleration short period (Sds) for Project is 74.8%g.
6. Project's Seismic Design Category: D.
7. Elevator Component Importance Factor: 1.5.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator 1 Description (Independent Living):

1. Elevator Number(s): 1
2. Type: Holeless, twinpost, 3-stage.
3. Emergency Service to elevator.
4. Rated Load: 3500 lb.
5. Rated Speed: 150 fpm.
6. Operation System: Selective-collective automatic.
7. Auxiliary Operations:
 - a. Automatic dispatching of loaded car.
 - b. Nuisance call cancel.
 - c. Loaded-car bypass.
8. Car Enclosures:
 - a. Inside Width: 65 inches from side wall to side wall.
 - b. Inside Depth: 80 inches from back wall to front wall (return panels).
 - c. Inside Height: 88 inches to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
 - e. Car Fixtures: Satin stainless steel, No. 4 finish.
 - f. Side and Rear Wall Panels: Plastic laminate.
 - g. Reveals: Enameled steel.
 - h. Door Faces (Interior): Satin stainless steel, No. 4 finish.
 - i. Door Sills: Aluminum, mill finish.
 - j. Ceiling: Satin stainless steel, No. 4 finish.
 - k. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
 - l. Floor: See Finish Schedule.
 - m. Buttons: G*,2,3,4,5
9. Hoistway Entrances:
 - a. Width: 42 inches.
 - b. Height: 84 inches.
 - c. Type: Two-speed side sliding.
 - d. Frames: Satin stainless steel, No. 4 finish.

- e. Doors: Satin stainless steel, No. 4 finish.
 - f. Sills: Aluminum, mill finish.
10. Hall Fixtures: Satin stainless steel, No. 4 finish.
11. Additional Requirements:
- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
 - b. Provide hooks for protective pads in all cars and one complete set(s) of full-height protective pads.

C. Elevator 2 Description (Independent Living):

- 1. Elevator Number(s): 1
 - 2. Type: Holeless, twinpost, 3-stage.
 - 3. Emergency Service to elevator.
 - 4. Rated Load: 3500 lb.
 - 5. Rated Speed: 150 fpm.
 - 6. Operation System: Selective-collective automatic.
 - 7. Auxiliary Operations:
 - a. Automatic dispatching of loaded car.
 - b. Nuisance call cancel.
 - c. Loaded-car bypass.
8. Car Enclosures:
- a. Inside Width: 65 inches from side wall to side wall.
 - b. Inside Depth: 80 inches from back wall to front wall (return panels).
 - c. Inside Height: 88 inches to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
 - e. Car Fixtures: Satin stainless steel, No. 4 finish.
 - f. Side and Rear Wall Panels: Plastic laminate.
 - g. Reveals: Enameled steel.
 - h. Door Faces (Interior): Satin stainless steel, No. 4 finish.
 - i. Door Sills: Aluminum, mill finish.
 - j. Ceiling: Satin stainless steel, No. 4 finish.
 - k. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
 - l. Floor: See Finish Schedule.
 - m. Buttons: G,2*,3,4,5
9. Hoistway Entrances:
- a. Width: 42 inches.
 - b. Height: 84 inches.
 - c. Type: Two-speed side sliding.
 - d. Frames: Satin stainless steel, No. 4 finish.
 - e. Doors: Satin stainless steel, No. 4 finish.
 - f. Sills: Aluminum, mill finish.

10. Hall Fixtures: Satin stainless steel, No. 4 finish.
11. Additional Requirements:
 - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
 - b. Provide hooks for protective pads in all cars and one complete set(s) of full-height protective pads.

2.4 SYSTEMS AND COMPONENTS

- A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.
 1. Pump shall be submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts or shall be tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and shall be mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch-thick, glass-fiber insulation board.
 2. Motor shall have wye-delta or solid-state starting.
 3. Motor shall have variable-voltage, variable-frequency control.
- B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.
- C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.
- D. Hydraulic Fluid: Nontoxic, biodegradable, fire-resistant fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives and approved by elevator manufacturer for use with elevator equipment.
- E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- F. Car Frame and Platform: Welded steel units.
- G. Guides: Roller guides; polymer-coated, nonlubricated sliding guides; or sliding guides with guide-rail lubricators. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.
- B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
 1. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors start closing.

2. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.

2.6 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

- A. General: Provide enameled-steel car enclosures to receive removable wall panels, with removable car roof, access doors, power door operators, and ventilation.
 1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
 1. Subfloor: Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.
 2. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to manufacturer's standard honeycomb core with plastic-laminate panel backing and manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected by Architect from plastic-laminate manufacturer's full range.
 3. Fabricate car with recesses and cutouts for signal equipment.
 4. Fabricate car door frame integrally with front wall of car.
 5. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet or by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
 6. Sight Guards: Provide sight guards on car doors.
 7. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
 8. Metal Ceiling: Flush panels, with LED downlights in the center of each panel. Align ceiling panel joints with joints between wall panels.
 9. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

2.8 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.

- B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.
 - 1. Fire-Protection Rating: As indicated with 30-minute temperature rise of 450 deg F.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 - 1. Enameled-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.
 - 2. Stainless-Steel Frames: Formed from stainless-steel sheet.
 - 3. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches high, on both inside surfaces of hoistway door frames.
 - 4. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet or by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
 - 5. Sight Guards: Provide sight guards on doors matching door edges.
 - 6. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
 - 7. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.9 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life lamps and acrylic or other permanent, non-yellowing translucent plastic diffusers or LEDs.
- B. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
 - 1. Mark buttons and switches for function. Use both tactile symbols and Braille.
 - 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
- D. Firefighters' Two-Way Telephone Communication Service: Provide SIP or network phone telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service.
- E. Hall Push-Button Stations: Provide one hall push-button station at each landing.
 - 1. Provide manufacturer's standard wall-mounted units.

2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
 3. Provide SIP or network phone telephone jack in each unit for firefighters' two-way telephone communication service.
- F. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:
1. Units mounted in both jambs of entrance frame for each elevator.
- G. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
1. At manufacturer's option, audible signals may be placed on cars.
- H. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Stainless-Steel Bars: ASTM A 276, Type 304.
- F. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- G. Aluminum Extrusions: ASTM B 221, Alloy 6063.
- H. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications and Type BKV for panel backing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.

- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
- B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.
- C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- D. Install piping above the floor, where possible. Install underground piping in casing.
- E. Lubricate operating parts of systems as recommended by manufacturers.
- F. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- G. Leveling Tolerance: 1/4 inch, up or down, regardless of load and travel direction.
- H. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- I. Locate hall signal equipment for elevators as follows, unless otherwise indicated:
 - 1. Place hall lanterns either above or beside each hoistway entrance.
 - 2. Mount hall lanterns at a minimum of 72 inches above finished floor.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

- A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for each elevator used for construction purposes:
1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 2. Provide strippable protective film on entrance and car doors and frames.
 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 5. Do not load elevators beyond their rated weight capacity.
 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
- B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 142400

DIVISION 21
FIRE SUPPRESSION

SECTION 210500 – FIRE PROTECTION GENERAL

PART 1 - GENERAL

1.1 SCOPE

- A. Design, fabricate, install, and secure required approvals for a complete fire protection automatic sprinkler [and standpipe] system where shown on the Drawings, as specified herein, and as needed for a complete and proper installation in accordance with pertinent requirements of NFPA 13, [NFPA 14,] and local governmental agencies having jurisdiction.
- B. Work includes providing design services, furnishing all labor, material, equipment and installation as necessary and reasonably incidental to the proper completion and proper operation of the fire protection systems. The work shall consist of but shall not necessarily be limited to the following:
 - 1. Standpipe System as specified in Section 21 12 00
 - 2. Automatic wet-pipe sprinkler system as specified in Section 21 13 13.
 - 3. Automatic dry-pipe sprinkler system as specified in Section 21 13 16.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 (General Requirements) sections of the Project Manual apply to this Section.
- B. The General Conditions shall be carefully examined before proposals for any work are submitted. Division 21 shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions unless Division 21 specifications contain statements more definitive or more restrictive.

1.3 DEFINITIONS

- A. Words and phrases used throughout the Contract Documents shall be interpreted as indicated below:
 - 1. Construction Documents – the basis for the work. It includes both the Drawings (plans) and Project Manual (specifications).
 - 2. Contractor – The person or organization awarded the contract for fire protection design and construction services.

In the case of a construction project administered as a multiple-prime contract, the term shall be further defined as the Contractor holding a prime contract for fire protection design and construction work.

The terms “Fire Protection Contractor” and “Sprinkler Contractor” may be used interchangeably with the term Contractor.

3. Provide – To furnish and install materials, equipment or systems.
4. Submittals – Submittals shall include Manufacturer's Catalog Data, Shop Drawings, Calculations, Certificates of Compliance, Testing Reports, Samples, and Operation and Maintenance Manuals.
5. Professional – The Architect and/or Engineer of record.
6. Work By Others – Work provided by a person or organization other than the Contractor.

1.4 CODES, REFERENCES, AND STANDARDS

- A. The Contractor shall comply with all laws, ordinances, and regulations of all Authorities Having Jurisdiction, including those of all applicable City, County, State, Federal and Public Utility entities. All licenses, permits, fees, inspection fees, etc., shall be obtained by the Contractor and the cost shall be included in the Contract price.
- B. The minimum standard of work under this contract shall be in accordance with the following model building codes and standards:
 1. International Code Council (ICC)
 - a. International Building Code with North Carolina Amendments
 - b. International Fire Prevention Code with North Carolina Amendments
 2. National Fire Protection Association
 - a. NFPA 13 – Standard for the Installation of Sprinkler Systems
 - b. NFPA 13R – Standard for the Installation of Sprinkler Systems in Low Rise Residential Occupancies
 - c. NFPA 14 – Standard for the Installation of Standpipe and Hose Systems
 - d. NFPA 70 – National Electric Code
- C. Other publications listed throughout Division 22 form a part of this specification to the extent referenced. All publications shall be the latest edition as adopted by the Authority Having Jurisdiction. The publications are referred to in the text by basic designation only.

1.5 QUALITY ASSURANCE, WORKMANSHIP AND COORDINATION

- A. The Contractor must coordinate his work with that of the other trades so that all work will be performed in an orderly manner and with the least possible interference. Where coordination with other trades is required, the Professional shall make the final decision regarding changes to be made in the work.
- B. The Contractor must thoroughly familiarize himself with all specifications and drawings for the project so that he clearly understands his responsibility in relationship to the work to be performed. The Contractor must plan and perform his work to permit the use of the building as soon as possible.

- C. The Contractor shall guarantee the workmanship, materials and equipment, furnished against defects, leaks, performance and non-operation for a period of one (1) year after the date of final acceptance. Defective workmanship shall be construed as meaning defective materials and unsatisfactory installation and not intended to apply to ordinary wear and tear. The Contractor shall pay for any repairs or replacements caused by defective workmanship as construed herein within the period covered by the Guarantee, including all incidental work required to correct the deficiency.
- D. The Contractor shall expressly and completely follow all manufacturers' instructions required for validation of the manufacturer's warranty agreement including but not limited to service, maintenance and adjustments of the equipment.
- E. The Contractor will be held responsible for the proper installation of all materials and equipment required for a complete installation within the intent and meaning of the Contract Documents.
 - 1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 2. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
- F. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

1.6 PROJECT RECORD DRAWINGS

- A. Deviations from the Contractor's approved Design and Fabrication Drawings necessary to coordinate the work with other trades, to conform to the building conditions or to conform to the rules and regulations of Authorities Having Jurisdiction shall be made only after obtaining written permission from the Professional.
- B. The Contractor shall keep a record of construction changes and deviations from the original Design and Fabrication Drawings. All changes shall be recorded on a separate set of prints which shall be kept at the job site specifically for that purpose. The record shall be made immediately after the work is completed. Documentation shall include:
 - 1. changes in pipe routing location
 - 2. valve locations
 - 3. Equipment locations, etc.
 - 4. actual capacities and values of equipment provided as indicated in equipment schedules
- C. The marked-up record set of drawings shall be submitted to the Professional for review and approval before final acceptance of the Fire Protection Contract work.

1.7 FIELD MEASUREMENTS

- A. Before ordering any equipment and material, or performing any work, the Contractor shall verify all measurements and dimensions at the job site and shall be held responsible for the correctness of same.
- B. No extra compensation will be allowed because differences between actual dimensions and measurements and those indicated on the Contractor's drawings.

1.8 PROTECTION OF SERVICES AND EQUIPMENT

- A. The Contractor, at his own expense, shall repair, replace and maintain in service any utilities, facilities or services (underground, aboveground, interior or exterior) damaged, broken, or otherwise rendered inoperative during construction due to activities on the part of the Contractor. The method used by the Contractor in repairing, replacing or maintaining the services shall be approved by the Professional.
- B. The Contractor shall protect, at his own expense, such of his work, materials or equipment that is subject to damage during the project duration. All openings into any piping, ducts or equipment must be securely covered, or otherwise protected, to prevent injury due to carelessly or maliciously dropped tools or materials, grit, dirt, or any foreign material. The Contractor shall be held responsible for all damage so done until his work is fully and finally accepted.
- C. It shall be the responsibility of the Contractor to protect motors, pumps, electrical equipment, and all similar items of equipment from dirt, grime, plaster, water, etc. during all phases of construction. This protection shall be provided by covering equipment with transparent plastic sheeting and/or locating the materials and equipment in an area free from the elements.

1.9 INTERRUPTION OF SERVICES

- A. The Contractor shall schedule his work to avoid any major interruption of any utility services.
- B. Existing utilities serving facilities occupied and used by the Owner or others shall not be interrupted except when such interruptions have been authorized in writing by the Owner or the Professional. Interruptions shall occur only after acceptable temporary utility services have been provided. The Contractor shall provide a minimum of ten (10) working days notice to the Professional and receive written notice to proceed before interrupting any utility.

1.10 CLEANUP

- A. The Contractor shall maintain buildings, grounds, and public properties free from accumulations of waste materials, debris and rubbish. At reasonable intervals during the progress of work, and when directed by the Owner's Authorized Representative, the site and public properties shall be cleaned and waste materials, debris and rubbish shall be disposed of in appropriate manner. The Contractor shall provide containers for collection of waste materials, debris and rubbish. Waste materials, debris and rubbish shall be removed from the job site and legally disposed of at a landfill area in accordance with all applicable regulations. Burning or burying waste materials, debris or rubbish on project site shall not be permitted.

- B. At the completion of the Project, remove waste materials, rubbish, tools, equipment, machinery, surplus materials, etc., and clean all sight-exposed fire protection fixtures and equipment. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from sight-exposed fire protection fixtures and equipment. Broom clean paved and concrete surfaces; rake clean other ground surfaces. Repair, patch and touch up marred surfaces to specified finish or to match adjacent surfaces.

1.11 SUBMITTALS

- A. Submittals shall be in accordance with Division 01 of the Project Manual.

- B. General

1. The Contractor shall provide to the Professional for review six (6) copies of required submittals, unless noted otherwise. All Catalog Data, Shop Drawings, Design (hydraulic) Calculations, and Certificates of Compliance shall be submitted as a single package. All delays to the job resulting from the Contractor's failure to provide submittals at one time will be the responsibility of the Contractor. Four (4) copies will be returned to the Contractor.
2. Submittals provided for review shall clearly and completely describe the specific product(s) they represent. Where differences exist between the item specified and that submitted for review, the submittal shall be highlighted.
3. Shop Drawings shall be prepared by a Certified NICET Level III technician. The plans should bear the signature, stamp and certificate number of the technician.
4. Submittals shall bear the review stamp of the Contractor. The review stamp of the Contractor shall be affixed to shop drawings to indicate:
 - a. The Contractor has coordinated the electrical characteristics of the equipment.
 - b. The Contractor has verified that the equipment submitted will physically fit into the space allocated with adequate clearances for maintenance, access, and egress requirements.
 - c. The Contractor shall bear all associated costs that may accrue due to failure to completely represent a given product.
5. Material and equipment shown on the drawings or specified herein shall not be incorporated in the work of this Contract until shop drawings, hydraulic calculations, engineering data and catalog information have been reviewed and accepted by the Professional.
6. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation.

- C. Operation and Maintenance Manuals

1. Submit two (2) sets of 8-1/2" x 11" text sixty (60) days prior to operator training/pre-final inspection bound in three D side ring capacity expansion binders with durable plastic covers for review by the Professional.
2. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS – FIRE PROTECTION SYSTEMS", title of project, and subject matter of binder when multiple binders are required.

3. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
4. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified type on thirty (30) pound white paper.
 - a. Part 1: Directory, listing names, addresses, and telephone numbers of Contractor, Subcontractors, and equipment suppliers.
 - b. Part 2: Operation and maintenance instructions arranged by system or process flow and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - 1) Significant design criteria.
 - 2) List of equipment.
 - 3) Parts list for each component.
 - 4) Maintenance instructions for equipment and systems.
 - 5) Maintenance instructions for finishes, including recommended cleaning methods and materials and operating instructions.
 - 6) Special precautions identifying detrimental agents.
 - 7) Special Requirements of other sections of this specification noted to be included in the operating and maintenance manual.
 - 8) Original copy (reproductions will not be accepted) of NFPA 25 – Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.
 - c. Part 3: Project documents and certificates, including the following:
 - 1) All approved Submittals
 - 2) Shop Drawings
 - 3) Hydraulic Calculations
 - 4) Certificates of Compliance
 - 5) Photocopies of warranties and bonds
 - 6) Material safety data sheets
5. Submit two (2) copies of completed volumes in final form fifteen (15) days prior to owner training. These copies will include Professional's previous review comments.

1.12 ELECTRICAL EQUIPMENT

- A. The Contractor shall furnish all motors, combination starters/disconnects, overload protection and controls for equipment required to provide complete and workable systems, unless noted otherwise.
- B. All motors, motor control equipment and wiring shall meet the requirements of the National Electric Code and shall comply with the requirements of the Public Utility Company furnishing service and with the rules and regulations of all Authorities Having Jurisdiction.
- C. The Contractor shall verify electrical characteristics at the site before ordering electrical equipment.

- D. Motors under ½ (one-half) horsepower shall be 120 volts. Motors ½ (one-half) horsepower and over shall be 3 (three) phase. All motors to be 1750 revolutions per minute (rpm) unless noted otherwise. Combination motor starters shall be of the fused switch type complete with magnetic motor starter. Units shall be of the NEMA size and type applicable to motor size, with 3-pole overload. Overload elements and fuses shall be of the proper size to protect the motor. Unless noted otherwise, units shall be equipped with indicating lights, HAND-OFF-AUTOMATIC (HOA) selector switch, four (4) auxiliary contacts two (2) normally open (N.O.) and two (2) normally closed (N.C.) and fused control transformer to provide 120-volt control voltage. Fusible disconnect switch operating handles shall be interlocked with the door so that the door cannot be opened with the switch in the "ON" position, except through a hidden release mechanism. The operating handle shall be arranged for padlocking in the "OFF" position with up to three padlocks. Fuses shall be furnished by the Contractor as required to comply with NEC requirements. Where R type fuses are indicated, fuse holders shall be provided with rejection clips. Equipment shall be Square D, Allen-Bradley, or General Electric or accepted substitute, and shall be provided with a NEMA Type 1 enclosure, unless noted otherwise.

1.13 CONTROL WIRING

- A. The Contractor shall provide all necessary control wiring and related conduit required for complete and workable systems.
- B. All conduit and wiring shall be in accordance with the latest edition of the National Electrical Code. Installation of control wiring shall be performed in a neat and workmanlike manner by competent workmen. Workmanship shall be as specified in Division 16.
- C. Control circuits shall be wired for 110-volt control, using fused individual control transformers. Circuits shall be fused and shall be interrupted when the disconnect device is opened.

1.14 INSPECTION AND TESTING

- A. General
1. New fire protection systems and parts of existing systems which have been altered, extended or repaired shall be tested to disclose leaks and defects.
 2. The Contractor shall notify the Professional a minimum of 5 (five) working days prior to testing to coordinate the testing and inspection procedures.
 3. If the Professional determines that the fire protection systems do not pass the prescribed tests, then the Contractor shall be required to make the necessary repairs, at his own expense, and the Contractor shall re-inspect and re-test the systems. Repairing, inspection and testing shall be continued until all systems pass as determined by the Professional.
 4. All new, altered, extended or replaced fire protection shall be left uncovered and unconcealed until it has been inspected, tested and accepted by the Professional. Where such work has been covered or concealed before it has been inspected, tested and accepted, it shall be uncovered by the Contractor, at his own expense as directed by the Professional.
 5. All equipment, material, labor, etc., required for testing the fire protection systems shall be furnished by the Contractor.

1.15 INSTRUCTION OF THE OWNER

- A. After acceptance of the Project, the Contractor shall furnish the services of personnel thoroughly familiar with the completed installation to instruct the Owner in the proper operation and maintenance of all equipment and appurtenances provided.
- B. The Contractor shall provide the Owner with two weeks' notice before the instruction session.

1.16 CHASES AND OPENINGS

- A. All chases and openings required for the installation of the work shall be coordinated with the other trades. The Contractor shall provide the other trades with sufficient time (1 (one) week minimum) for coordination of all chases and openings. The contractor shall be responsible for all work required to cut and patch the required openings. The work shall be performed to the satisfaction of the Professional.
- B. Penetrations made in fire rated chases, partitions, floors, etc., shall be sealed with an approved material and method as required to maintain the integrity of the fire separation.
- C. The Contractor shall provide all sleeves, hangers, and anchors required for installation of work in chases and openings.

1.17 WATER SERVICE

- A. The Contractor shall coordinate water service requirements in accordance with the local water utility regulations, including required permits, backflow preventers, meters, piping, valves, bypasses, supports and other accessories.

1.18 PAINTING

- A. Painting shall be in accordance with Division 09.

1.19 RELATED WORK

- A. All work related to providing complete fire protection systems and equipment shall be the responsibility of the Contractor. The following related work shall be provided as indicated in other specification Divisions, unless noted otherwise, but shall remain the responsibility of the Contractor for workmanship and completeness:

1. General Contractor

- a. Installation of access panels.
- b. Final painting of existing walls, floors and ceilings where the surfaces are being refinished and remodeled under the General Contract. Refer to General Construction Drawings.
- c. Concrete housekeeping pads for fire protection equipment.
- d. Removal of existing concrete housekeeping pads.

2. Electrical Contractor

- a. Verification of the proper rotation of three phase equipment, and making modifications as required to correct improper rotation.
- b. Installation of all combination starters/disconnects and overload protectors.

1.20 MISCELLANEOUS STEEL AND ACCESSORIES

- A. The contractor shall provide all necessary steel angles, channels, pipe, rods, nuts, bolts, etc., as shown on plans, as specified, or as may be required for complete and proper installation of sprinkler piping, systems and equipment. All material and workmanship shall be of the best quality and shall be installed in accordance with the best practices of the trade.

1.21 ACCESS PANELS

- A. The Contractor shall furnish access doors to the General Contractor for installation in ceilings, walls, partitions and floors for access to valve and other appurtenances.
- B. Access panels shall be of sufficient size to permit removal or access to equipment, except that the minimum size shall be 12-inches by 16-inches.
- C. Access door locations shall be as determined by field conditions for optimum access to equipment, and shall be reviewed by the Professional before final installation
- D. Access doors shall be suitable for installation in the finish material of the ceilings, walls, partitions and floors.
- E. Frame and panel access doors in restrooms, kitchens and as indicated shall be stainless steel.
- F. Access doors with UL Listing shall be provided in rated construction assemblies. Access doors shall be "B-Label" and shall have a UL one and one-half (1-1/2) hour rating at 250 degrees F rating for both door and frame. Maximum size shall be 20" x 20" or 400 square inches in area. Frame shall be sixteen (16) gauge minimum steel, panel shall be twenty (20) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), continuous type hinge on one side, flush-face type lock with key operation and self-latching cylinder locks.
- G. Access doors without UL label shall be provided in all non-rated construction assemblies: Frame shall be sixteen (16) gauge minimum steel, panel shall be fourteen (14) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), concealed spring type hinges and flush-face type lock with key operation and self-latching cylinder locks. Door shall open 175 degrees (minimum).
- H. All access doors shall be keyed alike.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials used on fire protection systems shall meet the requirements of applicable codes, standards, and requirements of Local Authorities Having Jurisdiction and the Owner's Insurance Carrier.

2.3 SPRINKLER AND STANDPIPE PIPING, ABOVE GROUND

- A. Piping: black steel meeting ASTM A53, ASTM A135, or ASTM A795.

1. Piping 2-½" and larger shall be Schedule 10 or the approximately equal "flow" products with roll-grooved, flanged or welded connections.

2. Piping 2" and smaller shall be Schedule 40 with threaded or welded connections.

3. Piping shall be hot-dipped galvanized where specified herein or noted on the drawings.

- B. Fittings: UL-listed, standard weight suitable for pressures up to 250 psig, cast iron meeting ASTM A126 or malleable iron meeting ASTM A197. Threaded cast iron fittings shall meet ANSI B16.4; flanged cast iron fittings shall meet ANSI B16.1. Threaded malleable iron fittings shall meet ANSI B16.3. Grooved fittings and couplings shall be UL-listed and shall be of ductile iron meeting ASTM A536, utilizing an EDPM gasket. Fittings shall be short pattern, with flow equal to standard pattern fittings. Plain-end fittings and couplings or welded-segmented fittings shall not be used. Changes in pipe diameter shall be made using tapered reducing fittings. Bushings or grooved end reducing couplings shall not be used unless standard reducing fittings are not regularly available.

1. Grooved joint couplings shall be:

- a. Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13. Couplings shall be fully installed at visual pad-to-pad offset contact. (Tongue and recess type couplings, or any coupling that requires exact gapping of bolt pads on each side of the coupling at specified torque ratings, are not allowed.)

1) 1-½" through 4": Installation-Ready, for direct stab installation without field disassembly. Victaulic Style 009-EZ.

2) Victaulic FireLock™ Style 005 or Zero-Flex Style 07.

- b. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for seismic applications. Victaulic Style 75 or 77.

2. Gaskets:

Fire Protection Service	Temp. Range	Gasket Recommendation
Dry Systems	Ambient	FlushSeal®, Grade EPDM, Type A
Freezer Applications	-40°F to 0°F	FlushSeal®, Grade L, Silicone
Water/Wet Systems	Ambient	Grade EPDM, Type A

- C. CPVC Pipe: ASTM F442, SDR 13.5 – ONLY VALID FOR RESIDENCE WET-PIPE AREAS

1. Fittings: ASTM F438 schedule 40, or ASTM F439 schedule 80, CPVC.
2. Joints: ASTM F493, solvent weld.

3. Requirements for the protection of CPVC piping shall be in accordance with the manufacturer's guidelines.

2.4 VALVES FOR FIRE PROTECTION SYSTEMS

- A. Gates Valves: Class 125, comply with MSS SP-80, bronze body, screwed bonnet, rising stem, solid wedge. 3" and larger; comply with MSS SP-70, iron body, bronze trim, rising stem, hand wheel, OS&Y, flanged or grooved ends. Basis of Design: Victaulic Series 771.
- B. Butterfly Valves:
 1. Comply with MSS SP-67, lug type, cast or ductile iron body, chrome plated ductile iron disk, EPDM seat, extended neck, handwheel and gear drive and integral indicating device, built-in tamper proof switch, 200 PSI rating.
 2. Grooved end type with ductile iron body, EPDM coated ductile iron disk with integrally cast stem, handwheel and gear drive and integral indicating devices, with weatherproof actuator and supervisory switches, 300 PSI rating. Victaulic Series 705W.
- C. Spring-Actuated Check Valves: 250 PSI rating, grooved end ductile iron one-piece body, stainless steel spring and shaft, suitable for vertical or horizontal installations. Victaulic Series 717.
- D. Check Valves: Class 125, comply with MSS SP-80 bronze body, screwed cap. "Y" pattern swing, bronze disc. 3" and larger, comply with MSS SP-71, class 125, iron body, bronze mounted, horizontal swing, cast iron disc.

2.5 DRAIN VALVES

- A. Provide bronze compression stop with hose thread nipple and cap.

PART 3 - EXECUTION

3.1 GENERAL

- A. All materials and equipment used shall be installed in strict accordance with the Standards under which the materials are accepted and approved, and in strict accordance with the manufacturer's instructions.
- B. The Contractor's Drawings shall indicate every bend, offset, change in direction and appurtenance required to provide a complete and workable system.
- C. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review

contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

3.2 SEISMIC RESTRAINTS

- A. Provide design and installation of seismic restraint elements for the plumbing system(s) in compliance with all applicable requirements of the 2015 International Building Code and ASCE 7-10, Chapter 13. Refer to the Appendix B on the Architectural drawings for the site's seismic design category (B, C or D).
- B. Refer to the latest edition of the "Seismic Restraint Manual Guidelines for Mechanical Systems" published by SMACNA to determine the correct restraints for piping.
- C. Provide calculations and prepare shop drawings for the specific methods of seismic restraint to be used in accordance with ASCE 7-10, Chapter 13. Required restraint devices, materials, and supplementary framing shall be an integral part of the design and included in the shop drawings. Provide isolators, seismic mounts, restraints, etc. as necessary to comply with all applicable requirements.
- D. Calculations shall be prepared by a certified or licensed professional NICET level III or IV certified designer with a minimum 5 years of experience in the design and specification of seismic restraint systems.
- E. Submit calculations and shop drawings to the Architect, Engineer, and local authority having jurisdiction for review and approval.
- F. Copies of the approved restraint system(s) installation manual shall be on the jobsite prior to installation.
- G. The Contractor shall be responsible for any required special inspections and associated documentation. The Contractor shall provide verification in writing of compliance with the approved shop drawings.
- H. Review and approval of the shop drawings and calculations by the Architect/Engineer/ shall not relieve the Contractor of his responsibility to comply with seismic or other requirements of the 2015 International Building Code and ASCE 7-10.

END OF SECTION 210500

SECTION 211200 - STANDPIPES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes entire standpipe system from fire department connection to fire hose connection.
- B. Related Sections:
 - 1. Section 21 05 00 - Fire Protection General

1.2 REFERENCES

- A. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved by Factory Mutual Research for Property Conservation.
- B. National Fire Protection Association:
 - 1. NFPA 14 - Standard for the Installation of Standpipe, Private Hydrants and Hose Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate supports, components, accessories, and sizes.
- C. Product Data: Submit manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories.
- D. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation.
- E. Field Test Reports: Indicate compliance with specified performance.
- F. Manufacturer's Installation Instructions: Submit with product data.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit servicing requirements and test schedule.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 14.

- B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- C. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver and store products in shipping packaging until installation.

1.8 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer warranty for standpipes and hoses.

1.9 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.1 VALVES

- A. Hose Connection Valve: Angle type; brass finish; 2-1/2-inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain.
- B. Hose Connection Valve Cabinets:
 - 1. Style: Recessed. Fire rated when installed in fire rated assemblies.
 - 2. Tub: 1 gage thick steel, prepared for pipe and accessory rough in.
 - 3. Door: 12 gage thick steel, glazed, with 1/4-inch-thick wired glass full panel, hinged, positive latch device.
 - 4. Finish: Enameled.

2.2 FIRE DEPARTMENT CONNECTION

- A. Flush mounted wall type with plated finish or free-standing type with ductile iron pedestal chrome plated finish, as indicated in the Fire Protection performance specification plans.
- B. Outlets: Two-way with fire department thread size. Threaded dust cap and chain of matching material and finish.
- C. Drain: 3/4-inch automatic drip, outside or connected to drain.
- D. Label: "Standpipe - Fire Department Connection".
- E. At the low-point near each fire department connection, install a 90-degree elbow with drain connection to allow for system drainage to prevent freezing. Basis of Design: Victaulic #10-DR.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify blocking in place for cabinet installation.

3.2 INSTALLATION

- A. Install in accordance with NFPA 14.
- B. Install cabinets plumb and level. Secure to adjacent surfaces. Establish top of cabinet (inside horizontal) surface 66 inches above finished floor or as noted on Architectural drawings.
- C. Install two-way fire department outlet on roof where indicated in the Fire Protection performance specification plans.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing and adjusting.
- B. Test entire system in accordance with NFPA 14.
- C. Require test be witnessed by Authority having jurisdiction.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Flush entire system of foreign matter.

END OF SECTION 211200

SECTION 211313 – WET-PIPE SPRINKLER SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes wet-pipe sprinkler system guidelines for system design, installation, and certification.
- B. Related Sections:
 - 1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 REFERENCES

- A. National Fire Protection Association:
 - 1. NFPA 13 - Installation of Sprinkler Systems.
 - 2. NFPA 13R - Standard for Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.

1.3 SYSTEM DESCRIPTION

- A. System to provide coverage for [entire building.] [building areas noted.]
- B. Provide a hydraulically designed system to NFPA 13 occupancy requirements.
- C. Obtain up-to-date flow test data. Determine volume and pressure of incoming water supply from water flow test data. Provide flow test data on the Shop Drawings.
- D. Interface sprinkler system with building fire and smoke alarm system.
- E. For new systems, provide fire department connections as indicated on Drawings.

1.4 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated
 - 1. Provide fire-hydrant flow test records to indicate the following conditions:
 - a. Time of test
 - b. Name and Company of person performing the test
 - c. Location of Residual Fire Hydrant
 - d. Location of Flow Fire Hydrant
 - e. Static Pressure at Residual Fire Hydrant

- f. Measured Flow at Flow Fire Hydrant
 - g. Residual Pressure at Residual Fire Hydrant
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Recommended Sprinkler Occupancy Hazard Classifications:
 - a. Automobile Parking Areas: Ordinary Hazard, Group 1
 - b. Building Service Areas: Ordinary Hazard, Group 1
 - c. Churches: Light Hazard
 - d. Electrical Equipment Rooms: Ordinary Hazard, Group 1
 - e. General Storage Areas: Ordinary Hazard, Group 1
 - f. Mechanical Equipment Rooms: Ordinary Hazard, Group 1
 - g. Office and Public Areas: Light Hazard
 - h. Repair Garages: Ordinary Hazard, Group 2
 - i. Residential Living Areas: Light Hazard
 - 3. Recommended Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Residential (Dwelling) Occupancy: 0.05 gpm over 400-sq. ft. area.
 - b. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - d. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - 4. Maximum Protection Area per Sprinkler: Per UL listing.
 - 5. Maximum Protection Area per Sprinkler:
 - a. Residential Areas: 400 sq. ft.
 - b. Office Spaces: 225 sq. ft.
 - c. Storage Areas: 130 sq. ft.
 - d. Mechanical Equipment Rooms: 130 sq. ft. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: Per NFPA 13 recommendations unless otherwise indicated.
 - 6. Total Combined Hose-Stream Demand Requirement: Per NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
 - c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes
 - 7. Seismic Performance: Refer to section 21 05 00

1.13 SUBMITTALS

- A. Division 01 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Provide layout of finished ceiling areas indicating sprinkler locations coordinated with ceiling installation and the work of other trades (ductwork, lights and any other ceiling mounted devices). Show detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
- C. Product Data: Submit data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- D. Design Data: Submit design calculations signed and sealed by a professional engineer.
- E. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.14 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and inspector's test locations.
- C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.15 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 13.

1.16 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.
- C. Design system under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location (state).

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Product Requirements: Product storage and handling requirements.
- B. Store products in shipping containers until installation.
- C. Furnish piping with temporary inlet and outlet caps until installation.

1.18 WARRANTY

- A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five (5) year manufacturer warranty for system components.

1.19 EXTRA MATERIALS

- A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish extra sprinklers under provisions of NFPA 13.
- C. Furnish suitable wrenches for each sprinkler type.
- D. Furnish metal storage cabinet in location designated by Architect, adjacent to system riser.

PART 2 PRODUCTS

2.1 SPRINKLERS

- A. Suspended Ceiling Type (Public Areas):
 - 1. Type: Recessed pendant type with matching escutcheon plate.
 - 2. Finish: Chrome plated.
 - 3. Fusible Link: temperature rated for specific area hazard.
- B. Suspended Ceiling Type (Residential Areas):
 - 1. Type: Recessed pendant type with matching escutcheon plate.
 - 2. Finish: Painted white (verify with Architect)
 - 3. Fusible Link: temperature rated for specific area hazard.
- C. Exposed Area Type:
 - 1. Type: Standard upright type.
 - 2. Finish: Brass.
 - 3. Fusible Link: temperature rated for specific area hazard.
- D. Side wall Type:
 - 1. Type: Standard horizontal side wall type with matching escutcheon plate.
 - 2. Finish: Chrome plated (Public Areas) or painted white (Residential Areas).
 - 3. Fusible Link: temperature rated for specific area hazard.
- E. Guards: Finish to match sprinkler finish.

2.2 PIPING SPECIALTIES

- A. Wet Pipe Sprinkler Riser Check Valve: Ductile iron body, swing check type valve with brass seat and rubber-faced or aluminum-bronze clapper with elastomer seal. Provide complete with main drain valve and pressure gauges. Rated for 250 psi working pressure.

Valve internal components shall be replaceable without removing from the installed position.

- B. Electric Alarm: Electrically operated gong with pressure alarm switch.
- C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125-volt AC and 2.0 amp at 24 volt DC.
- D. Fire Department Connections:
 - 1. Flush mounted wall type with chrome plated finish or free-standing type with ductile iron pedestal chrome plated finish, as indicated in the Fire Protection performance specification plans.
 - 2. Outlets: Two-way with fire department thread size. Threaded dust-cap and chain of matching material and finish.
 - 3. Drain: 3/4-inch automatic drip, outside or connected to drain.
 - 4. Label: "Sprinkler - Fire Department Connection"
 - 5. At the low-point near each fire department connection, install a 90-degree elbow with drain connection to allow for system drainage to prevent freezing. Elbow shall be Victaulic #10-DR.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA 13.
 - *** delete note below if backflow is provided by site utility contractor (most common) ***
- B. Install approved back-flow preventer assembly, type as indicated in the Fire Protection performance specification plans, at sprinkler system water source connection.
- C. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent fire department connectors to allow full swing of fire department wrench handle.
- D. Locate outside alarm-gong on building wall as indicated on Drawings.
- E. Place pipe runs to minimize obstruction to other work.
- F. Install piping in concealed spaces above finished ceilings.
- G. Center sprinklers in two directions in ceiling tile and install piping offsets.
 - 1. The Victaulic Aqua-Flex stainless steel flexible drop system may be used to properly locate sprinkler heads. The drop system shall be supplied with required supporting members and bracing.
- H. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
- I. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

- J. Install guards on sprinklers where required to protect sprinklers from physical damage.
- K. Hydrostatically test entire system.
- L. Require test be witnessed by authority having jurisdiction.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Verify signal devices are installed and connected to fire alarm system.

3.3 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Flush entire piping system of foreign matter.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

END OF SECTION 211313

SECTION 211316 – DRY-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes dry-pipe sprinkler system guidelines for system design, installation, and certification.
- B. Related Sections:
 - 1. Section 21 05 13 - Common Motor Requirements for Fire-Suppression Equipment: Product requirements for motors for placement by this section.
 - 2. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product requirements for vibration isolators for placement by this section.
 - 3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 REFERENCES

- A. National Fire Protection Association:
 - 1. NFPA 13 - Installation of Sprinkler Systems.

1.3 SYSTEM DESCRIPTION

- A. System to provide coverage for entire building.
- B. Provide a hydraulically designed system to NFPA 13 occupancy requirements.
- C. Obtain up-to-date flow test data. Determine volume and pressure of incoming water supply from water flow test data. Provide flow test data on the Shop Drawings.
- D. Interface system with building fire and smoke alarm system.
- E. For new systems, provide fire department connections as indicated on Drawings.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Provide layout of finished ceiling areas indicating sprinkler locations coordinated with ceiling installation and the work of other trades (ductwork, lights and any other ceiling mounted devices). Show detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.

- C. Product Data: Submit data on sprinklers, valves, pumps, compressors and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- D. Design Data: Submit design calculations signed and sealed by a professional engineer.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 13.

1.7 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.
- C. Design system under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location (state).

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Store products in shipping containers until installation.
- C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five (5) year manufacturer warranty for air compressor and pump.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish extra sprinklers under provisions of NFPA 13.
- C. Furnish suitable wrenches for each sprinkler type.
- D. Furnish metal storage cabinet in location designated by Architect, adjacent to system riser.

PART 2 PRODUCTS

2.1 SPRINKLERS

- A. Suspended Ceiling Type:
 - 1. Type: Recessed pendant type with matching escutcheon plate.
 - 2. Finish: Chrome plated.
 - 3. Fusible Link: temperature rated for specific area hazard.
- B. Suspended Ceiling Type:
 - 1. Type: Recessed pendant type with matching escutcheon plate.
 - 2. Finish: Painted white (verify with Architect).
 - 3. Fusible Link: temperature rated for specific area hazard.
- C. Exposed Area Type:
 - 1. Type: Standard upright type with guard.
 - 2. Finish: Brass.
 - 3. Fusible Link: temperature rated for specific area hazard.
- D. Side wall Type:
 - 1. Type: Standard horizontal side wall type with matching escutcheon plate and guard.
 - 2. Finish: Chrome plated.
 - 3. Escutcheon Plate Finish: Chrome plated.
 - 4. Fusible Link: temperature rated for specific area hazard.
- E. Guards: Finish to match sprinkler finish.
- F. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.2 PIPING SPECIALTIES

- A. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced or aluminum-bronze clapper with elastomer seal to automatically actuate water motor alarm [and electric alarm], with accelerator [; with test and drain]. Valve internal

components shall be replaceable without removing the valve from the installed position. Valve shall be externally resettable. Required air pressure shall be 13 psi / 90 kPa.

- B. Electric Alarm: Electrically operated gong with pressure alarm switch.
- C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125-volt AC and 2.0 amp at 24 volt DC.
- D. Fire Department Connections:
 - 1. Flush mounted wall type with chrome plated finish or free-standing type with ductile iron pedestal chrome plated finish, as indicated in the Fire Protection performance specification plans.
 - 2. Outlets: Two-way with fire department thread size. Threaded dust-cap and chain of matching material and finish.
 - 3. Drain: 3/4-inch automatic drip, outside or connected to drain.
 - 4. Label: "Sprinkler - Fire Department Connection"
 - 5. At the low-point near each fire department connection, install a 90-degree elbow with drain connection to allow for system drainage to prevent freezing. Elbow shall be Victaulic #10-DR.

2.3 AIR COMPRESSOR

- A. Compressor: Single unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloading valve.

2.4 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: In accordance with Section 26 05 03 and the following:
 - 1. [[] hp.] [[] rated load amperes.]
 - 2. [] volts, [single] [three] phase, 60 Hz.
 - 3. [] amperes maximum [fuse size] [circuit breaker size] [overcurrent protection].
 - 4. [] minimum circuit ampacity.
 - 5. [] percent minimum power factor at rated load.
- B. Motors: In accordance with Section 21 05 13.
- C. Controls: Supervisory switches, Water Level Supervisory Switches, Tank Temperature Supervisory Switches, Room Temperature Supervisory Switches.
- D. Disconnect Switch: Factory mount in control panel or on equipment.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA 13.

- B. Install approved back-flow preventer assembly, type as indicated in the Fire Protection performance specification plans, at sprinkler system water source connection.
- C. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of fire department wrench handle.
- D. Install outside alarm-gong on building wall as indicated on Drawings
- E. Install piping to minimize obstruction with other work.
- F. Install piping in concealed spaces above finished ceilings.
- G. Center sprinklers in two directions in ceiling tile and install piping offsets.
 - 1. The Victaulic EZ-Flex stainless steel flexible drop system may be used to properly locate sprinkler heads. The drop system shall be supplied with required supporting members and bracing.
- H. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
- I. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.
- J. Install guards on sprinklers where required to protect sprinklers from physical damage.
- K. Install air compressor on vibration isolators. Refer to Section 21 05 48.
- L. Hydrostatically test entire system.
- M. Require test be witnessed by authority having jurisdiction.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Verify devices are installed and connected to fire alarm system.

3.3 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Flush entire piping system of foreign matter.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Apply masking tape or paper cover to sprinklers, cover plates, and sprinkler escutcheons not receiving field painted finish. Remove after painting. Replace painted sprinklers with new.

END OF SECTION 211316

DIVISION 22
PLUMBING

SECTION 220500 – PLUMBING GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 (General Requirements) sections of the Project Manual apply to this Section.
- B. The General Conditions shall be carefully examined before proposals for any work are submitted. Division 22 shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions unless Division 22 sections contain statements more definitive or more restrictive.

1.2 SCOPE

- A. Provide all labor, material, equipment and services necessary and reasonably incidental to the proper completion and proper operation of the building plumbing systems. The work shall consist of but shall not necessarily be limited to the following:
 - 1. Domestic water system including extension of piping and connections to all fixtures and/or equipment. The domestic water system shall be extended from a point 5 (five) feet beyond the exterior face of the building.
 - 2. Sanitary drain, waste and vent system including extension of piping and connection to all fixtures and/or equipment. The sanitary system shall be extended to a point 5 (five) feet beyond the exterior face of the building.
 - 3. Rainwater collection system including extension of piping to roof drains. The rainwater collection system shall be extended to a point 5 (five) feet beyond the exterior face of the building.

1.3 DEFINITIONS

- A. Words and phrases used throughout the Contract Documents shall be interpreted as indicated below:
 - 1. Construction Documents – the basis for the work. It includes both the Drawings (plans) and Project Manual (specifications).
 - 2. Contractor – The person or organization awarded the contract for construction services.

In the case of a construction project administered as a multiple-prime contract, the term shall be further defined as the Contractor holding a prime contract for plumbing construction work.
The term “Plumbing Contractor” is used interchangeably with the term “Contractor”.
 - 3. Provide – To furnish and install materials, equipment or systems.

4. Submittals – Submittals shall include Manufacturer’s Catalog Data, Shop Drawings, Calculations, Certificates of Compliance, Testing Reports, Samples, and Operation and Maintenance Manuals.
5. Professional – The Architect and/or Engineer of record.
6. Work by Others – Work provided by a person or organization other than the Contractor.

1.4 CODES, REFERENCES AND STANDARDS

- A. The Contractor shall comply with all laws, ordinances, and regulations of all Authorities Having Jurisdiction, including those of all applicable City, County, State, Federal and Public Utility entities. All licenses, permits, fees, connection fees, tapping fees, inspection fees, etc., shall be obtained by the Contractor and the cost shall be included in the Contract price.
- B. The minimum standard of work under this contract shall be in accordance with the following model building codes:
 1. 2015 (ICC) International Codes:
 - a. International Building Code.
 - b. International Plumbing Code.
 - c. International Mechanical Code.
 - d. International Fire Prevention Code.
 - e. International Gas Code
 - f. International Energy Code.
- C. Other publications listed throughout Division 22 form a part of this specification to the extent referenced. All publications shall be the latest edition as adopted by the Authority Having Jurisdiction. The publications are referred to in the text by basic designation only.

1.5 QUALITY ASSURANCE, WORKMANSHIP AND COORDINATION

- A. The Contractor must coordinate his work with that of the other trades so that all work will be performed in an orderly manner and with the least possible interference. Where coordination with other trades is required, the Professional shall make the final decision regarding changes to be made in the work.
- B. The Contractor must thoroughly familiarize himself with all the Construction Documents for the project so that he clearly understands his responsibility in relationship to the work to be performed. The Contractor must plan and perform his work to permit the use of the building as soon as possible.
- C. The Contractor shall guarantee the workmanship, materials, and equipment, furnished against defects, leaks, performance and non-operation for a period of one (1) year after the date of final acceptance. Defective workmanship shall be construed as meaning defective materials and unsatisfactory installation and not intended to apply to ordinary wear and tear. The Contractor shall pay for any repairs or replacements caused by defective workmanship as construed herein within the period covered by the Guarantee, including all incidental work required to correct the deficiency.

- D. The Contractor shall expressly and completely follow all manufacturers' instructions required for validation of the manufacturer's warranty agreement including but not limited to service, maintenance and adjustments of the equipment.
- E. The Contractor shall be held responsible for the proper installation of all materials and equipment required for a complete installation within the intent and meaning of the Contract Documents.

1.6 PROJECT RECORD DRAWINGS

- A. Changes from the Contract Drawings necessary to coordinate the work with other trades, to conform to the building conditions or to conform to the rules and regulations of Authorities Having Jurisdiction shall be made only after obtaining written permission from the Professional.
- B. The Contractor shall keep a record of construction changes and deviations from the original Contract Drawings. All changes shall be recorded on a separate set of prints which shall be kept at the job site specifically for that purpose. The record shall be made immediately after the work is completed. Documentation shall include:
 - 1. location and elevation of new and existing utility lines
 - 2. points of connection to existing utility lines
 - 3. changes in pipe routing location
 - 4. valve locations
 - 5. equipment locations, etc.
 - 6. actual capacities and values of equipment provided as indicated in equipment schedules
- C. The marked-up record set of drawings shall be delivered to the Professional before final acceptance of the Plumbing Contract work.

1.7 FIELD MEASUREMENTS

- A. It shall be the Contractor's responsibility to verify the location of any and all existing underground utilities in the vicinity of his work. When it has been indicated that these utilities are to remain in place, the Contractor shall provide adequate means of support and protection during excavation operations.
- B. Before ordering any equipment and material, or performing any work, the Contractor shall verify all measurements and dimensions at the job site and shall be held responsible for the correctness of same.
- C. No extra compensation will be allowed because differences between actual dimensions and measurements and those indicated on the drawings.
- D. Any difference which may be found shall be submitted to the Professional for consideration before proceeding with the work.

1.8 PROTECTION OF SERVICES AND EQUIPMENT

- A. The Contractor, at his own expense, shall repair, replace and maintain in service any utilities, facilities or services (underground, aboveground, interior or exterior) damaged, broken, or otherwise rendered inoperative during construction due to activities on the part

of the Contractor. The method used by the Contractor in repairing, replacing or maintaining the services shall be approved by the Professional.

- B. The Contractor shall protect, at his own expense, such of his work, materials or equipment that is subject to damage during the project duration. All openings into any piping, ducts or equipment must be securely covered, or otherwise protected, to prevent injury due to carelessly or maliciously dropped tools or materials, grit, dirt, or any foreign material. The Contractor shall be held responsible for all damage so done until his work is fully and finally accepted.
- C. It shall be the responsibility of the Contractor to protect motors, pumps, electrical equipment, and all similar items of equipment from dirt, grime, plaster, water, etc. during all phases of construction. This protection shall be provided by covering equipment with transparent plastic sheeting and/or locating the materials and equipment in an area free from the elements.

1.9 INTERRUPTION OF SERVICES

- A. The Contractor shall schedule his work to avoid any major interruption of any utility services.
- B. Existing utilities serving facilities occupied and used by the Owner or others shall not be interrupted except when such interruptions have been authorized in writing by the Owner or the Professional. Interruptions shall occur only after acceptable temporary utility services have been provided. The Contractor shall provide a minimum of ten (10) working days' notice to the Professional and receive written notice to proceed before interrupting any utility.

1.10 CLEANUP

- A. The Contractor shall maintain buildings, grounds and public properties free from accumulations of waste materials, debris and rubbish. At reasonable intervals during the progress of work, and when directed by the Owner's Authorized Representative, the site and public properties shall be cleaned and waste materials, debris and rubbish shall be disposed of in appropriate manner. The Contractor shall provide containers for collection of waste materials, debris and rubbish. Waste materials, debris and rubbish shall be removed from the job site and legally disposed of at a landfill area in accordance with all applicable regulations. Burning or burying waste materials, debris or rubbish on project site shall not be permitted.
- B. At the completion of the Project, remove waste materials, rubbish, tools, equipment, machinery, surplus materials, etc., and clean all sight-exposed plumbing fixtures and equipment. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from sight-exposed plumbing fixtures and equipment. Broom clean paved and concrete surfaces; rake clean other ground surfaces. Repair, patch and touch up marred surfaces to specified finish or to match adjacent surfaces.

1.11 SUBMITTALS

- A. Submittals shall be in accordance with Division 01 of the Project Manual.
- B. General

1. The Contractor shall provide to the Professional for review 6 (six) copies of required submittals, unless noted otherwise. All Catalog Data, Shop Drawings, Calculations, and Certificates of Compliance shall be submitted as a single package. Failure of the contractor to provide a complete submittal package may result in delay in processing time. All such delays to the job resulting from the contractor's failure to provide submittals at one time will be the responsibility of the Contractor. Three (3) copies will be returned to the Contractor. Submittals shall clearly identify the contract documents specification section or drawing referenced, identifying and highlighting each item to be reviewed.
2. Submittals provided for review shall clearly and completely describe the specific product(s) they represent. Where differences exist between the item specified and that submitted for review, the submittal shall be highlighted.
3. Submittals shall bear the review stamp of the Contractor. The review stamp of the Contractor shall be affixed to shop drawings to indicate:
 - a. The Contractor has coordinated the electrical characteristics of the equipment.
 - b. The Contractor has verified that the equipment submitted will physically fit into the space allocated with adequate clearances for maintenance, access, and egress requirements.
 - c. The Contractor shall bear all associated costs that may accrue due to failure to completely represent a given product.
4. Material and equipment shown on the drawings or specified herein shall not be incorporated in the work of this Contract until shop drawings, engineering data and catalog information have been reviewed and accepted by the Professional.

C. Trade Name References

1. Material and equipment are described and listed in the Project Documents by trade name, by manufacturer's name and model number, or by performance attributes. It is intended that trade names or manufacturer's names shall establish standards of quality, performance, capacity, materials, and design for the item specified.
2. Where more than one manufacturer is listed for an item, those mentioned are considered equivalent if the quality, style, capacities, materials and performance of the specified item are equivalent. All materials and equipment shall be subject to the acceptance by the Professional.

D. Substitutions

1. No substitution shall be made without the review and acceptance by the Professional.
2. Where the phrase "or accepted substitute" or "or equal" appears in the Contract Documents, it shall refer to the requirement of acceptance by the Professional of the material or equipment involved.
3. It shall be the responsibility of the Contractor to ensure that each manufacturer can furnish a substitute in complete conformity with the requirements of this Project. The Contractor shall assume all costs or extra charges associated with the substitution,

including: any architectural, structural, mechanical, or electrical changes required, costs in connection with work of the other trades necessitated substitutes, and any additional engineering costs required.

4. The Contractor shall indicate the specified equivalent on shop drawings or catalog data which are submitted as substitutions.
5. At the request of the Professional samples of items that are to be used in substitution of specified items shall be submitted. If such a request is made, a sample of both the specified item and the proposed substitute item shall be submitted simultaneously. The scheduling of the submission of such samples shall be as directed and shall in no way delay the progress of the project. The Professional will assume no liability whatsoever for any samples submitted.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Operation and Maintenance Manuals shall be in accordance with Division 01 of the Project Manual.

B. General

1. Submit two (2) sets of 8-1/2" x 11" text sixty (60) days prior to operator training/pre-final inspection bound in three D side ring capacity expansion binders with durable plastic covers for review by the Professional.
2. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.
3. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
4. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified type on thirty (30) pound white paper.
 - a. Part 1: Directory, listing names, addresses, and telephone numbers of Professional, Contractor, Subcontractors, and equipment suppliers.
 - b. Part 2: Operation and maintenance instructions arranged by system or process floor and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - 1) Significant design criteria.
 - 2) List of equipment.
 - 3) Parts list for each component.
 - 4) Maintenance instructions for equipment and systems.
 - 5) Maintenance instructions for finishes, including recommended cleaning methods and materials and Operating instructions.
 - 6) Special precautions identifying detrimental agents.
 - 7) Special Requirements of other sections of this specification noted to be included in the operating and maintenance manual.

c. Part 3: Project documents and certificates, including the following:

- 1) All approved Submittals
- 2) Certificates of Compliance
- 3) Photocopies of warranties and bonds
- 4) Material safety data sheets

5. Submit five (5) copies of completed volumes in final form fifteen (15) days prior to owner training. These copies will include Professional's previous review comments.

6. Submit eight final volumes revised, within ten (10) days after pre-final observation.

1.13 ELECTRICAL EQUIPMENT

- A. The Contractor shall furnish all motors, combination starters/disconnects, overload protection and controls for equipment required to provide complete and workable systems, unless noted otherwise.
- B. All motors, motor control equipment and wiring shall meet the requirements of the National Electric Code and shall comply with the requirements of the Public Utility Company furnishing service and with the rules and regulations of all Authorities Having Jurisdiction.
- C. The contractor shall verify electrical characteristics at the site before ordering electrical equipment.
- D. Motors under ½ (one-half) horsepower shall be 120 volts. Motors ½ (one-half) horsepower and over shall be 3 (three) phases. All motors to be 1750 revolutions per minute (rpm) unless noted otherwise. Combination motor starters shall be of the fused switch type to complete with magnetic motor starter. Units shall be of the NEMA size and type applicable to motor size, with 3-pole overload. Overload elements and fuses shall be of the proper size to protect the motor. Unless noted otherwise, units shall be equipped with indicating lights, HAND-OFF-AUTOMATIC (HOA) selector switch, 4 (four) auxiliary contacts 2 (two) normally open (N.O.) and 2 (two) normally closed (N.C.) and fused control transformer to provide 120-volt control voltage. Fusible disconnect switch operating handles shall be interlocked with the door so that the door cannot be opened with the switch in the "ON" position, except through a hidden release mechanism. The operating handle shall be arranged for padlocking in the "OFF" position with up to three padlocks. Fuses shall be furnished by the Contractor as required to comply with NEC requirements. Where R type fuses are indicated, fuse holders shall be provided with rejection clips. Equipment shall be Square D, Allen-Bradley, or General Electric or accepted substitute, and shall be provided with a NEMA Type 1 enclosure, unless noted otherwise.

1.14 CONTROL WIRING

- A. The Contractor shall provide all necessary control wiring and related conduit required for complete and workable systems.
- B. All conduit and wiring shall be in accordance with the latest edition of the National Electrical Code. Installation of control wiring shall be performed in a neat and workmanlike manner by competent workmen. Workmanship shall be as specified in Division 26.

- C. Control circuits shall be wired for 110-volt control, using fused individual control transformers. Circuits shall be fused and shall be interrupted when the disconnect device is opened.

1.15 EXCAVATION, BACKFILLING AND COMPACTION

- A. Excavation, Backfilling and Compaction shall comply with Division 31 of the Project Manual

- B. General

1. The Contractor shall notify one call prior to any work.
2. The Contractor shall perform all excavation, backfilling, compaction and necessary finishing for all piping, equipment, and accessories. Piping installation shall be in accordance with local water, sewer and gas utility regulations and applicable State and Local codes.
3. Protect existing structures, utilities, sidewalks, pavements and other facilities not indicated for removal, from damage caused by settlement, lateral movement, undermining, washout and other hazards resulting from excavation operations.
4. Existing utility lines shown on the Project Documents may not indicate the exact in-place location of the lines. They do not show every pipe, fitting or appurtenance that may exist at the project site. The location and depth of all utilities shall be marked and recorded prior to any excavation. Should uncharted or incorrectly charted, existing piping or other utilities be uncovered during excavation, contact the Professional immediately for directions before proceeding further with work in this area. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.
5. If it becomes necessary to install any lines or equipment in locations other than those shown, the Professional's acceptance shall be obtained before starting the excavation.
6. The presence of explosives on the project site or the use of explosives in the execution of the work under this contract is not permitted.

- C. Excavation

1. All plumbing excavation is unclassified.
2. Trenches shall be dug to uniform width not less than 12-inches or more than 16-inches wider than the bell diameter of the piping. Trench sides shall be vertical. Excavate trenches to depth indicated or required. Carry depth of trenches for piping as required to establish required slopes and invert elevations. Beyond building perimeter, keep bottom of trenches sufficiently below finished grade to protect against frost. The bottom of trenches shall be accurately graded to provide uniform and smooth flow throughout. Any over-excavation shall be backfilled with modified aggregate and thoroughly tamped.
3. If trench excavation operations are performed when the atmospheric temperature is less than thirty-five (35) degrees Fahrenheit, the Contractor shall provide at his own expense cold weather protection as required to protect excavated trench bottoms from

freezing. Under no circumstances will any pipe be permitted to be laid in a trench containing water or on a subgrade containing frost.

4. Take up and re-lay pipe that is not laid true to required alignment or grade. Pipe that has had its joints disturbed after laying shall be taken up and relayed. Deviation from the required lines and grades will not be permitted unless approved by the Professional.
5. Pipe Embedment – All pipe shall be laid on a First-Class granular bedding. The bedding shall be a minimum depth of 6-inches (six) or $\frac{1}{4}$ (one-fourth) the pipe diameter, whichever is greater. The bedding shall provide uniform longitudinal support to the pipe and shall be laid to provide the grade and line as shown on the drawings or as directed by the Professional. Compaction of embedment materials under the haunches and around the pipe to the springline of the pipe shall be by hand tamping. Final embedment for ferrous pipe materials shall extend from the springline of the pipe to a depth of 6-inches (minimum) above the top of the pipe. Final embedment for PVC pipe shall extend from the springline of the pipe to a depth of 18-inches (minimum) above the top of the pipe.

D. Compaction

1. Comply with Division 31 of the Project Manual.

1.16 CONCRETE

- A. Comply with Division 03 of the Project Manual.
- B. Reinforcing shall conform to ASTM A-615, Grade 60. Concrete exposed to freezing and thawing, salts, sulfates and corrosion shall comply with International Building Code with North Carolina amendments.
- C. All concrete shall be of minimum 3000 pounds per square inch (psi) strength in 28 (twenty-eight) days. All concrete shall be mixed by machine. No wet or moistened mixture containing cement shall remain unplaced for a period exceeding 30 (thirty) minutes and shall not be used after its initial set. Re-tempering after initial set is prohibited. Exposed surfaces shall be protected from drying for at least 7 (seven) days. All forms shall be built true and rigid. Form removal shall not injure the concrete.
- D. All concrete is to be finished with a hard, smooth troweled finish and is to be faced smooth with rounded corners.

1.17 INSPECTION AND TESTING

- A. General
 1. New plumbing systems and parts of existing systems which have been altered, extended or repaired shall be tested to disclose leaks and defects.
 2. The Contractor shall notify the Professional a minimum of 5 (five) working days prior to testing to coordinate the testing and inspection procedures.
 3. If the Professional determines that the plumbing systems do not pass the prescribed tests, then the Contractor shall be required to make the necessary repairs, at his own expense, and the Contractor shall re-inspect and re-test the systems. Repairing,

inspection and testing shall be continued until all systems pass as determined by the Professional.

4. All new, altered, extended or replaced plumbing shall be left uncovered and unconcealed until it has been inspected, tested and accepted by the Professional. Where such work has been covered, or concealed before it has been inspected, tested and accepted, it shall be uncovered by the contractor, at his own expense as directed by the Professional.
5. All equipment, material, labor, etc., required for testing the plumbing systems shall be furnished by the Contractor.

B. Sanitary, Vent, and Rainwater Collection Systems

1. The system shall be tested in accordance with the referenced State Plumbing Code.
2. Rough Plumbing – Systems shall be tested upon completion of the rough piping installation and proved watertight. The water test shall be applied to the system either in its entirety or in sections after rough piping has been installed.
 - a. Where applied to the entire system, all openings in the piping shall be closed, except the highest opening, and the system filled with water to point of overflow.
 - b. Where the system is tested in sections, each opening shall be plugged, except the highest opening of the section under test, and each section shall be filled with water. A section shall not be tested with less than a 10-foot head of water.
 - c. In testing successive sections, at least the upper 10-feet of the next preceding section shall be tested, such that a joint or pipe in the building, except the uppermost 10 feet of the system, shall not have been subjected to a test of less than a 10-foot head of water.
 - d. The water shall be kept in the system or in the portion under test for a minimum of 2 (two) hours before inspection starts. The system shall then be inspected to ensure that it is tight at all points.
 - e. The Contractor shall provide a written Test and Inspection Report that the above prescribed test(s) have been performed in accordance with these Specifications. The report is subject to approval by the Professional.
3. Finished Plumbing – After the plumbing fixtures have been set and their traps filled with water, the plumbing fixture connections shall be tested and proved gas and watertight.
 - a. A smoke test shall be made by filling all traps with water and then introducing into the system smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be introduced and maintained for the period of the inspection.
 - b. Where the local Authority Having Jurisdiction finds that a smoke test need not be performed, a peppermint test shall be performed. Two (2) ounces of oil of

peppermint shall be poured into the roof terminal of every line or stack to be tested. The oil of peppermint shall be followed at once by 10 quarts of hot (140-degrees Fahrenheit) water. All roof vent terminals shall then be sealed. The system shall then be inspected for the detection of odor of peppermint. If odor of peppermint is detected, repairs shall be made and the system shall be retested.

- c. The above tests shall be witnessed by the Authority Having Jurisdiction or by Professional or his representative or by the Commissioning Agent.
- d. The Contractor shall provide a written Test and Inspection Report that the above prescribed test(s) have been performed in accordance with these Specifications. The report is subject to approval by the Professional.

C. Building Sewer

- 1. The building sewer shall be tested by insertion of a test plug at the point of connection with the public sewer. The building sewer shall then be filled with water under a head of not less than 10-feet. The water level at the top of the test head of water shall not drop for at least 15 (fifteen) minutes.

D. Domestic Water Systems

- 1. The system shall be tested either in its entirety or in sections.
- 2. The system shall be tested and proved tight under a water pressure of 125 pounds per square inch for a period of 2 hours.
- 3. Potable water shall be used for testing.

E. Fuel Gas Systems

- 1. The systems shall be tested in accordance with NFPA 54.
- 2. All fuel gas piping shall be pneumatically tested for tightness prior to commencement of gas service. Air or nitrogen shall be used as the test medium. The piping system shall be pressurized to 100 psig for a period of 2 hours. All joints shall be leak tested with detection solution while the system is pressurized. The Contractor shall provide a valved ¼ inch FPT connection in the system to which shall be attached a 24-hour pressure recording gauge. The Contractor shall arrange for a gas company representative to witness the test. Leaks shall be repaired by tightening or replacing joints. Caulking of joints is not permitted.

1.18 STERILIZATION OF THE DOMESTIC WATER SYSTEM

- A. After the system has been tested and approved, the entire new system, including valves and accessories, shall be chlorinated. Disinfecting shall be in accordance with AWWA C651.
- B. Chlorine may be applied in any of the following forms:
 - 1. Liquid chlorine gas-water mixture
 - a. Chlorine gas-water mixture shall be applied by a solution feed chlorinating device.

2. Direct chlorine gas feed
 - a. Chlorine gas shall be fed directly from a chlorine cylinder with a suitable device for regulating the rate of flow and the effective diffusion of gas within the line.
 3. Calcium hypochlorite and water mixture.
 - a. Calcium hypochlorite shall be HTH, Perchlorene and Maxochlor, or accepted substitute. A solution consisting of five (5%) percent powder to ninety-five (95%) percent water by weight shall be prepared. The calcium hypochlorite and water mixture, first made into a paste and then thinned to a slurry, shall be injected or pumped into the system.
- C. The system or part thereof shall be filled with a water/chlorine solution containing at least 50 parts per million of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million of chlorine and allowed to stand for 3 hours. During the chlorination process all valves and accessories shall be operated.
- D. After the chlorination process, the chlorine shall be flushed from the system until the system water is equal in chemical and bacteriological composition to those of the permanent source of water supply.
- E. Laboratory tests of the water shall be paid for by the Contractor.

1.19 INSTRUCTION OF THE OWNER

- A. After acceptance of the Project, the Contractor shall furnish the services of personnel thoroughly familiar with the completed installation to instruct the Owner in the proper operation and maintenance of all equipment and appurtenances provided.
- B. The Contractor shall provide the Owner with two weeks' notice before the instruction session.

1.20 CHASES AND OPENINGS

- A. All chases and openings required for the installation of the work shall be coordinated with the other trades. The Contractor shall provide the other trades with sufficient time (1 (one) week minimum) for coordination of all chases and openings. The contractor shall be responsible for all work required to cut and patch the required openings. The work shall be performed to the satisfaction of the Professional.
- B. Penetrations made in fire rated chases, partitions, floors, etc. shall be sealed with an approved material and method as required to maintain the integrity of the fire separation.
- C. The Contractor shall provide all sleeves, hangers, and anchors required for installation of the work in chases and openings.

1.21 WATER SERVICE AND METERS

- A. The Contractor shall coordinate water meter requirements in accordance with the local water utility regulations, including required permits, meters, piping, valves, by passes, supports and other accessories.

1.22 PAINTING

- A. Painting of plumbing system piping and/or equipment shall be in accordance with Division 09 of the Project Manual.

1.23 RELATED WORK

- A. All work related to providing complete plumbing systems and equipment shall be the responsibility of the Contractor. The following related work shall be provided as indicated in other specification Divisions, unless noted otherwise, but shall remain the responsibility of the Contractor for workmanship and completeness:

- 1. Owner Provided Equipment

- a) As noted or indicated on the Drawings.

- 2. General Contractor

- a) Installation of access panels.
 - b) Leaders and gutters.
 - c) Foundation drains. Final connections shall be by the Contractor, as indicated on the drawings and as herein specified.
 - d) Final painting of existing walls, floors and ceilings where the surfaces are being refinished and remodeled under the General Contract. Refer to General Construction Drawings.
 - e) Equipment and furnishings including shop equipment and laboratory equipment. Final connections to all equipment and furnishings shall be provided by the Contractor. The Contractor shall be responsible for coordination of plumbing services with the equipment and furnishings.
 - f) Installation and flashing of roof penetrations including but not limited to roof drains, vents through roof, gas piping, etc. Final connections shall be provided by the Contractor.
 - g) Casework mounted sinks and lavatories, including faucets, bubblers, strainers, tailpieces, traps, gas cocks, and inter-connecting piping. The Contractor shall install the sinks, equipment and appurtenances and shall make final plumbing connections. Rough-in plumbing work shall be in accordance with rough-in drawings as furnished by the General Contractor. Final connections to all fixtures shall be provided by the Contractor. The Contractor shall be responsible for coordination of plumbing services with the fixtures and equipment.
 - h) Concrete housekeeping pads for plumbing equipment.
 - i) Removal of existing concrete housekeeping pads.

- 3. Mechanical Contractor

- a) Steam supply and return piping.
 - b) Condensate drain piping.

- 4. Electrical Contractor

- a) Installation of all combination starters/disconnects and overload protectors.

1.24 MISCELLANEOUS STEEL AND ACCESSORIES

- A. The contractor shall provide all necessary steel angles, channels, pipe, rods, nuts, bolts, etc., as shown on plans, as specified, or as may be required for complete and proper

installation of plumbing fixtures, systems and equipment. All material and workmanship shall be of the best quality and shall be installed in accordance with the best practices of the trade.

1.25 ACCESS PANELS

- A. The Contractor shall furnish access doors to the General Contractor for installation in ceilings, walls, partitions and floors for access to valves, traps, fittings, and all appurtenances.
- B. Access panels shall be of sufficient size to permit removal or access to equipment, except that the minimum size shall be 12-inches by 16-inches.
- C. Access door locations shall be as determined by field conditions for optimum access to equipment and shall be reviewed by the Professional before final installation, and shall be subject to the following.
 - 1. Bottom of access doors shall not be lower than the top of the partition base, or a minimum of 6 inches above floor.
 - 2. Tops and/or sides of access panels shall be a minimum of 6-inches from the ceiling or opening or from the edge of a wall return.
- D. Access doors shall be suitable for installation in the finish material of the ceilings, walls, partitions and floors.
- E. Frame and panel access doors in restrooms, kitchens and as indicated shall be stainless steel.
- F. Access doors with UL Listing shall be provided in rated construction assemblies. Access doors shall be "B-Label" and shall have a UL one and one-half (1-1/2) hour rating at 250 degrees F rating for both door and frame. Maximum size shall be 20" x 20" or 400 square inches in area. Frame shall be sixteen (16) gauge minimum steel, panel shall be twenty (20) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), continuous type hinge on one side, flush-face type lock with key operation and self-latching cylinder locks.
- G. Access doors without UL label shall be provided in all non-rated construction assemblies: Frame shall be sixteen (16) gauge minimum steel, panel shall be fourteen (14) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), concealed spring type hinges and flush-face type lock with key operation and self-latching cylinder locks. Door shall open 175 degrees (minimum).
- H. All access doors shall be keyed alike.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials used on plumbing systems shall comply with the following lead ban requirements:

1. Solders with lead content exceeding 0.2% (two-tenths of a percent) are prohibited. Brass and bronze materials containing 8.0% (eight percent) or greater lead are prohibited.

PART 3 - EXECUTION

3.1 GENERAL

- A. All materials and equipment used shall be installed in strict accordance with the Standards under which the materials are accepted and approved, and in strict accordance with the manufacturer's instructions.
- B. The Contract Documents are not intended to indicate every bend, offset, change in direction and appurtenance required to provide a complete and workable system.
- C. The contract drawings are diagrammatic and are indicative of the work to be performed. It is not intended that they show every pipe, fitting or apparatus required for a complete installation.
- D. Except where otherwise indicated, minimum cover shall not be less than the following:
 1. sanitary sewer piping: 3'-0"
 2. storm sewers: 1'-0"
 3. water piping: 3'-0"
 4. gas piping: 2'-0"

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

3.3 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 SEISMIC RESTRAINTS

- A. Provide design and installation of seismic restraint elements for the plumbing system(s) in compliance with all applicable requirements of the 2015 International Building Code and ASCE 7-10, Chapter 13. Refer to the Appendix B on the Architectural drawings for the site's seismic design category (B, C or D).
- B. Refer to the latest edition of the "Seismic Restraint Manual Guidelines for Mechanical Systems" published by SMACNA to determine the correct restraints for piping.
- C. Provide calculations and prepare shop drawings for the specific methods of seismic restraint to be used in accordance with ASCE 7-10, Chapter 13. Required restraint devices, materials, and supplementary framing shall be an integral part of the design and included in the shop drawings. Provide isolators, seismic mounts, restraints, etc. as necessary to comply with all applicable requirements.
- D. Calculations shall be prepared by a certified or licensed professional a professional engineer licensed in the State of Missouri with a minimum 5 years of experience in the design and specification of seismic restraint systems.
- E. Submit calculations and shop drawings to the Architect, Engineer, and local authority having jurisdiction for review and approval.
- F. Copies of the approved restraint system(s) installation manual shall be on the jobsite prior to installation.
- G. The Contractor shall be responsible for any required special inspections and associated documentation. The Contractor shall provide verification in writing of compliance with the approved shop drawings.
- H. Review and approval of the shop drawings and calculations by the Architect/Engineer/ shall not relieve the Contractor of his responsibility to comply with seismic or other requirements of the 2015 International Building Code and ASCE 7-10.

END OF SECTION 220500

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the following systems:

1. Domestic water piping within 5 feet of building.
2. Sanitary waste and vent piping, within 5 feet of building.
3. Storm water piping within 5 feet of building.
4. Equipment drains and overflows.
5. Natural Gas piping.
6. Flue and Combustion Air piping for sealed combustion, direct vent water heaters.
7. Unions and flanges.
8. Underground pipe markers.

B. Related Sections:

1. Division 08 - Access Doors and Frames
2. Division 09 - Painting
3. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
4. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
5. Section 22 07 00 - Plumbing Insulation.
6. Division 31 - Excavation, Trenching and Backfill

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
3. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
4. ASTM B75 - Standard Specification for Seamless Copper Tube.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
6. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
7. ASTM D1784 – Rigid Chlorinated Poly (Vinyl Chloride) (CPVC) Vinyl Compounds.
8. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
9. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
10. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
11. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- D. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 3. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
- E. Cast Iron Soil Pipe Institute:
1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 2. CISPI 310 – Standard Specification for Couplings for use with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 3. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe institute (CISPI) and be listed by NSF International.

1.3 SUBMITTALS

- A. Division 01 - Submittal Procedures.
- B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.
- D. Welders' Certificate: Include welders' certification of compliance with ASME Section IX.
- E. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.
- C. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum 10 years documented experience.
- C. Design pipe hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Division 01 - Requirements for coordination.
- B. Coordinate installation of buried piping with trenching.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

Pipe 3 inch and larger:

- A. Ductile Iron Pipe: AWWA C151.
 - 1. Fittings: AWWA C110, ductile or gray iron, standard thickness.
 - 2. Joints: AWWA C111, rubber gasket with rods.

Pipe 2½ inch and smaller:

- B. Copper Tubing: ASTM B88, Type K hard drawn or annealed.
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints:

- a. 2" and smaller: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
- b. 2-1/2" and larger: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE, GREATER THAN 2" SIZE

A. Chlorinated Polyvinyl Chloride (CPVC): ASTM D 2846, Copper Tube Size.

- 1. Fittings: Copper Tube Size ASTM D 2846,
- 2. Joints: Copper Tube Size, ASTM D 2846, solvent weld with ASTM F 493 CPVC solvent cement

2.3 DOMESTIC WATER PIPING, ABOVE GRADE, GREATER THAN 2" SIZE (FOR USE IN ALL MECHANICAL ROOMS)

A. Copper Tubing: ASTM B88, Type L hard drawn.

- 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
- 2. Joints:
 - a. 2" and smaller: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
 - b. 2-1/2" and larger: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
 - c. 1-1/2" and smaller: Copper, Push-To-Connect Fittings: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper with stainless steel teeth and EPDM synthetic rubber o-ring seal in each end (UL classified in accordance with NSF-61 for hot (+180°F) and cold (+86°F) potable water service) with push-to-connect ends instead of solder-joint ends.

B. Copper Tubing: ASTM B88, Type L hard drawn, rolled grooved ends.

- 1. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings,] grooved ends.
- 2. Joints: Grooved mechanical couplings meeting ASTM F1476.
 - a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, cast with offsetting, angle-pattern bolt pads to provide rigidity, copper-colored enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion. "Installation-Ready" design for direct stab installation onto roll grooved copper tube without field disassembly. Victaulic Style 607 QuickVic™.
 - 1) Installation-Ready Fittings for Grooved Copper Tube: Ductile-iron cast housing; PVDF fitting liner; two integrated Installation-Ready couplings with EHP – EDPM gaskets. For use on n 2"-3"

- K, L, M, and DWV copper, rated for -30°F to +180°F. UL Classified in accordance with ANSI/NSF 61 for cold and hot potable water service and ANSI/NSF 372.
- b. Gasket: Elastomer composition, Grade “EHP” EPDM synthetic rubber gasket (UL/ULC classified in accordance with ANSI/NSF-61 for domestic water service) for operating temperature range from -30 degrees F to ~~230~~ 250 degrees F.
- c. Accessories: Stainless steel bolts, nuts, and washers.

2.4 DOMESTIC WATER PIPING, ABOVE GRADE, 2” SIZE AND LESS

- A. Cross Linked Polyethylene (PEX) piping, ASTM F876, and cold expansion fittings (ASTM F1960).
 - 1. SDR9 crosslinked polyethylene manufactured using the Engel method (PEX-a)
 - a. Minimum degree of cross-linking shall be between 70-89% when tested in accordance with ASTM D2765, Method B.
 - 2. Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent, third-party agency.
 - a. Piping to have minimum designation of PEX 5106.
 - 3. Potable water piping shall comply with NSF 14 and NSF 61 and bear the “NSF-pw” marking.
 - 4. Temperature and pressure requirements in accordance with PPI TR-3: 73.4°F at 80 psi, 180°F at 100 psi, and 200°F at 80 psi.
 - 5. Provide PEX-a pipe support or pipe support channel that continuously supports the pipe with strapping.
 - 6. Manufactured Joint: ½ inch through 2 inch nominal pipe size.
 - a. ASTM F1960 cold-expansion fitting manufactured from the following material types:
 - 1) UNS No. C69300 Lead-free (LF) Brass.
 - 2) 20% glass-filled polysulfone as specified in ASTM D6394
 - 3) Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394
 - 4) Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
 - 5) Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394.
 - b. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping and marked “F1960”.
 - c. Potable water fittings shall comply with NSF 14 and NSF 61 and bear the “NSF-pw” marking.

7. Mechanical Joint: ½ inch through 2 inch nominal pipe size.
 - a. SDR9 compression-type fitting consisting of a nut, compression ring and insert.
 - b. Compression fitting shall comply with ASTM F877, NSF 14 and NSF 61.
8. Mechanical Joint: 1 inch through 2 inch nominal pipe size.
 - a. SDR9 compression-type fitting consisting of a double o-ring insert with a compression sleeve tightened around the pipe and insert.
 - b. Compression fitting shall comply with ASTM F877, NSF 14 and NSF 61.
- B. Copper Tubing: ASTM B88, Type L hard drawn.
 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
- C. Copper Tubing: ASTM B88, Type L hard drawn, rolled grooved ends.
 1. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings,] grooved ends.
 2. Joints: Grooved mechanical couplings meeting ASTM F1476.
 - a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, cast with offsetting, angle-pattern bolt pads to provide rigidity, copper-colored enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion. "Installation-Ready" design for direct stab installation onto roll grooved copper tube without field disassembly.
 - b. Gasket: Elastomer composition, Grade "EHP" EPDM synthetic rubber gasket (UL/ULC classified in accordance with ANSI/NSF-61 for domestic water service) for operating temperature range from -30 degrees F to 250 degrees F.
 - c. Accessories: Stainless steel bolts, nuts, and washers.

2.5 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Soil Pipe: ASTM A74, service weight, bell and spigot ends.
 1. Fittings: Cast iron, ASTM A74.
 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
- B. Cast Iron Pipe: CISPI 301, hub-less.

1. Fittings: Cast iron, CISPI 301.
 2. Joints: CISPI 310, ASTM C1540-15, Heavy-Duty assemblies of corrugated stainless-steel shield/housing, stainless steel bands with corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral center stop.
- a. Accepted Manufacturers:
- 1) NDS Clamp-All
 - 2) Anaco-Husky
 - 3) Mission Rubber Company
 - 4) Mifab MI-QXHUB

Do not use PVC pipe for high temperature wastewater (140° F or higher).

- C. PVC Pipe: ASTM D2665, Solid Wall, Schedule 40, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.

1. Fittings: ASTM D2466, Schedule 40, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

2.6 SANITARY WASTE AND VENT PIPING, ABOVE GRADE: LOCATED IN RETURN AIR PLENUMS

- A. Cast Iron Pipe: ASTM A888; CISPI 301, hub-less, service weight, plain ends.

1. Fittings: Cast iron, CISPI 301.
2. Joints: ASTM C1540 – Heavy duty, neoprene sealing sleeve (ASTM D3677) and stainless steel clamp-and-shield assemblies.

- B. Copper Tube: ASTM B306, DWV.

1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.7 SANITARY WASTE AND VENT PIPING, ABOVE GRADE: LOCATED IN ALL AREAS ABOVE GRADE OTHER THAN RETURN AIR PLENUMS

- A. PVC Pipe: ASTM D2665, polyvinyl chloride (PVC) material.

1. Fittings: ASTM D2665, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

- B. PVC Pipe: ASTM D1785 Schedule 40 polyvinyl chloride (PVC) material.

1. Fittings: ASTM D2466, Schedule 40, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

- C. Couplings: Victaulic Style 177, 77, or 75 flexible type couplings only may be used with schedule 40 or 80 PVC pipe at ambient temperatures not exceeding 100 deg F.

2.8 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74, service weight, bell and spigot ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hub-less, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: CISPI 310, ASTM C1540-15, Heavy-Duty assemblies of corrugated stainless-steel shield/housing, stainless steel bands with corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral center stop.
 - a. Accepted Manufacturers:
 - 1) NDS Clamp-All
 - 2) Anaco-Husky
 - 3) Mission Rubber Company
 - 4) Mifab MI-QXHUB
- C. PVC Pipe: ASTM D2665 or ASTM D3034, polyvinyl chloride (PVC) material.
 - 1. Fittings: PVC, ASTM D2665 or ASTM D3034.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- D. PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679, polyvinyl chloride (PVC) material.
 - 1. Fittings: PVC, ASTM D2665, ASTM D3034, or ASTM F679.
 - 2. Joints: ASTM F477, elastomeric gaskets.

2.9 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hub-less, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: CISPI 310, ASTM C1540-15, Heavy-Duty assemblies of corrugated stainless-steel shield/housing, stainless steel bands with corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral center stop.
 - a. Accepted Manufacturers:
 - 1) NDS Clamp-All
 - 2) Anaco-Husky
 - 3) Mission Rubber Company
 - 4) Mifab MI-QXHUB
- B. PVC Pipe: ASTM D2665 or ASTM D3034, polyvinyl chloride (PVC) material.
 - 1. Fittings: ASTM D2665 or ASTM D3034, PVC.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.10 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type DWV.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.11 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M forged steel welding type.
 - 2. Joints: ASME B31.9, welded.
 - 3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
- B. SDR11 polyethylene, (PB2306/PE2405), ASTM D2513. The contractor shall submit a letter from the Gas Service Provider confirming their approval of this material.
 - 1. Heat fusion or mechanical joints.

2.12 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.13 FLUE AND COMBUSTION AIR PIPING

- A. CPVC Pipe: ASTM F441, Schedule 40, chlorinated polyvinyl chloride (CPVC) material.
 - 1. Fittings: ASTM F441, Schedule 40, CPVC.
 - 2. Joints: solvent weld with ASTM F493 solvent cement.
- B. Stainless Steel Vent System: UL 1738, AL29-4C.
 - 1. All flue-gas carrying components of the vent system shall be obtained from a single manufacturer.
 - 2. Stainless steel vent system shall be warranted by the manufacturer against defects in material and workmanship for a period of (15) years from the date of manufacture.
 - 3. Vent shall be factory-built special gas type, single wall, engineered and designed for use on Category I, II, III, and IV appliances, or as specified by the equipment manufacturer.
 - 4. Vent shall be constructed of AL29-4C or 29-4 (S44735) superferritic stainless steel with minimum thickness of 0.015" for diameters 3"-8" and 0.020" for diameters 10"-16".
 - 5. All conduit components shall be manufactured from AL29-4C or 29-4 (S44735). The joint closure system shall be a Ring-and-Tab mechanism that is

- integral to each joint. Use of gasket lube, available from the factory, should be used for maximizing gasket life and ease of installation.
6. Joints shall be designed with a male and female overlapping metal-metal connection to maintain condensate on the AL29-4C stainless steel. Proper 1/4" per foot pitch must be maintained at all times and condensate should flow back toward the appliance to the required number of drains.
 7. Vent shall be rated for an internal static pressure of 9" w.g.
 8. All parts shall be compatible with other single wall or double wall products of the same manufacturer.

2.14 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered joints.
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
4. PVC Piping: PVC.
5. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. PVC Piping: PVC flanges.
4. CPVC Piping: CPVC flanges.
5. Gaskets: 1/16-inch-thick preformed neoprene gaskets.

C. Flange Adapter for Pipe 2 inches and Larger:

1. Ferrous Piping: Class 125, 150 & 300, ductile iron, flat faced. Victaulic Style 741, 743 & W741.
2. Copper Piping: 300 psi, ductile iron coated with copper-colored enamel, flat faced. Victaulic Style 641.

D. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 01 - Verification of existing conditions before starting work.
- B. Verify excavations are to required grade, dry, and not over-excavated.
- C. Verify trenches are ready to receive piping.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to site piping system size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 2 ft of cover.
- C. Establish minimum separation from other services in accordance with applicable codes.
- D. Install plastic pipe as required per ASTM D2321.
- E. Install pipe to elevation as indicated on Drawings.
- F. Install pipe on prepared bedding.
- G. Route pipe in straight line.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Install plastic ribbon tape continuous, buried 12 inches below finish grade and above pipeline; coordinate with Division 31. Refer to Section 22 05 00.
- J. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 22 05 00.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.
- G. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08.
- H. Install non-conducting dielectric connections wherever jointing dissimilar metals.

- I. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum (1/4 inch per foot for 2" pipes). Maintain gradients.
- J. Slope piping and arrange systems to drain at low points.
- K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- L. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- M. Install valves in accordance with Section 22 05 23.
- N. Insulate piping. Refer to Section 22 07 00.
- O. Install pipe identification in accordance with Section 22 05 53.
- P. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation and visually verify correct installations. Contractor shall remove and replace any improperly installed products. At the owner's discretion, Victaulic inspection services may be requested to review every Victaulic joint on the job site.
- Q. Vic Press 304™ Pressure-Sealed Joints: Pipe shall be certified for use with the Vic Press 304™ system. Pipe shall be square cut, +/- 0.030", properly deburred and cleaned. Pipe ends shall be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly. Use a Victaulic "PFT" Series tool with the proper sized jaw for pressing.

3.5 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

- A. Install domestic water piping system in accordance with ASME B31.9.
- B. Pipes carrying pressurized water and laid under the building shall be installed with NO joints.

3.6 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

- A. Install sanitary waste and vent piping systems in accordance with ASME B31.9.
- B. Install sanitary waste and vent piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.

3.7 INSTALLATION - STORM DRAINAGE PIPING SYSTEMS

- A. Install storm drainage piping systems piping in accordance with ASME B31.9.
- B. Install storm drainage piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.

3.8 INSTALLATION - GAS PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide support for utility meters in accordance with requirements of utility company.
- C. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
- D. Install gas pressure regulator vent full size opening on regulator and terminate outdoors or as indicated on Drawings.

3.9 FIELD QUALITY CONTROL

- A. Refer to Division 01 - Execution and Closeout Requirements: Field inspecting, testing and adjusting.
- B. Test domestic water piping system in accordance with applicable code. Refer to Section 22 05 00.
- C. Test sanitary waste and vent piping system in accordance with applicable code. Refer to Section 22 05 00.
- D. Test storm drainage piping system in accordance with applicable code. Refer to Section 22 05 00.
- E. Pressure test natural gas piping in accordance with NFPA 54.

3.10 CLEANING

- A. Division 01 – Execution and Closeout Requirements: Field inspecting, testing and adjusting.
- B. Clean and disinfect domestic water distribution system in accordance with Section 22 05 00.

END OF SECTION 220503

SECTION 220523 – GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gate valves.
2. Ball valves.
3. Plug valves.
4. Butterfly valves.
5. Check valves.

B. Related Sections:

1. Section 22 05 03 – Plumbing Pipe, Tube and Fittings
2. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
3. Section 22 07 00 - Plumbing Insulation

1.2 REFERENCES

A. ASTM International:

1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
2. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

- B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

1.4 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of valves.
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

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 years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install valves underground when bedding is wet or frozen.

1.8 WARRANTY

- A. Division 01 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year manufacturer warranty for valves excluding packing.

1.9 EXTRA MATERIALS

- A. Division 01 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish two packing kits for each size valve.

PART 2 - PRODUCTS

2.1 GATE VALVES

A. Manufacturers:

1. Apollo Valves, Conbraco Company.
2. Crane Valve, North America.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO, Inc.
6. Stockham Valves & Fittings.

- B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, rising stem, hand-wheel, inside screw with back-seating stem, solid wedge disc, alloy seat rings, solder or threaded ends.
- C. 2-1/2 inches and Larger: MSS SP 70, Class 125, cast iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 BALL VALVES

A. Manufacturers:

1. Apollo Valves, Conbraco Company.
2. Crane Valve, North America.
3. Hammond Valve Model.
4. Jomar Valve
5. Milwaukee Valve Company.
6. NIBCO, Inc. Model.
7. Stockham Valves & Fittings Model.
8. Victaulic

- B. 4 inch and Smaller: MSS SP 110, 600 psi WOG, two-piece brass or bronze body, chrome plated brass ball and stem, full port, PTFE seats, blow-out proof stem, solder or threaded ends, lever handle.
- C. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two-piece body, type 316 stainless steel ball, full port, Teflon seats, blow-out proof stem, solder or threaded ends, lever handle.

- D. Drain valves at bottom of domestic water risers: 3/4" in size, MSS SP 110, 600 psi WOG, two-piece brass or bronze body, full port, blowout-proof stem, stainless steel ball and stem, solder end x 3/4" hose connection with cap and chain, lever handle. NIBCO S-585-70-66-HC. JOMAR S-100HSG
- E. 2 inches and smaller: MSS SP 110, 300 psi CWP, forged brass two-piece body, chrome-plated brass ball and stem, TFE seats, Fluoro-elastomer seals, blow-out proof stem, pressure-sealed ends, lever handle. Victaulic Series 589.
- F. 1-1/2" and smaller: MSS SP 110, 200 psi CWP, forged brass two-piece body, chrome-plated copper alloy ball and copper alloy stem, PTFE seats, Fluorocarbon or ring stem seal, push-to-connect ends, lever handle. Victaulic 300 Series.
- G. 2 inches and Smaller: 150 psi at 73 degrees F water temperature, maximum service temperature: 210 degrees F, ASTM D1784 CPVC body and ball, double lever handle, EPDM or fluorocarbon seals, Teflon seats, full port, single union type with socket ends.

2.3 PLUG VALVES

- A. Manufacturers:
 - 1. DeZURIK, Unit of SPX Corp.
 - 2. Flow Control Equipment, Inc.
 - 3. Homestead Valve.
- B. 2 inches and Smaller: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, Teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
- C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, Teflon packing, flanged ends. Furnish wrench operated.

2.4 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Apollo Valve, Conbraco Company
 - 2. Crane Valve, North America.
 - 3. Hammond Valve.
 - 4. Jomar Valve
 - 5. Milwaukee Valve Company.
 - 6. NIBCO, Inc.
 - 7. Stockham Valves & Fittings.
 - 8. Victaulic Series Vic®-300 Master Seal™ and Vic®-300 AGS.
- B. 2-1/2 inches and Larger: MSS SP 67, Class 200.

1. Body: Cast or ductile iron, lug or grooved ends, stainless steel stem, extended neck.
2. Disc: Chrome plated, electro-less nickel coated, or PPS coated ductile iron or stainless steel, offset disc to provide continuous 360-degree seating.
3. Seat: Resilient replaceable EPDM [Buna N for compressed air applications].
4. Handle and Operator: Infinite position lever handle with memory stop, gear operator with hand-wheel or power actuator.

2.5 CHECK VALVES

A. Horizontal Swing Check Valves:

1. Manufacturers:
 - a. Apollo Valve, Conbraco Company.
 - b. Crane Valve, North America
 - c. Hammond Valve.
 - d. Jomar Valve
 - e. Milwaukee Valve Company.
 - f. NIBCO, Inc.
 - g. Stockham Valves & Fittings.
 - h. Victaulic Company.
2. 2 inches and Smaller: MSS SP 139, Class 150, bronze body and cap, bronze seat, Buna-N or PTFE disc, solder or threaded ends.
3. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast-iron disc, renewable disc seal and seat, flanged ends.
4. 2 inches through 4 inches: 300 psi, cast ductile iron body, bonnet cap drilled and tapped with 1/2" NPT, stainless steel Type 316 clapper and clapper pin, grooved ends, Teflon, EPDM or fluoro-elastomer seat and EPDM, fluoro-elastomer bonnet gasket.

B. Spring Loaded Check Valves:

1. Manufacturers:
 - a. Apollo Valve, Conbraco Company
 - b. Crane Valve, North America.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.

- e. NIBCO, Inc.
 - f. Stockham Valves & Fittings.
 - g. Victaulic Company.
2. 2 inches and Smaller: MSS SP 139, Class 250 bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
 3. 2-1/2 inches and Larger: MSS SP 71, Class 125, wafer or globe style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.
 4. 2 inches through 3 inches: 365 psi CWP rating, non-slam, silent type with ductile iron body, stainless steel spring, brass shaft and stainless steel disc seats against the o-ring seal which is mounted on the electro-less nickel-plated end face. Victaulic Series 716H.
 5. 4 inches through 12 inches: 300 psi CWP rating, non-slam, silent type with ductile iron body and stainless-steel spring and shaft. Victaulic Series 716 and Series 779 with venturi-taps.
 6. 14 inches through 24 inches: 230 psi CWP rating, ductile iron body, spring actuated stainless steel disc and shaft, EPDM seat bonded to the valve body. Victaulic Series W715.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install 3/4-inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- D. Install valves with clearance for installation of insulation and allowing access.
- E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08.
- F. Refer to Section 22 05 29 for pipe hangers.
- G. Refer to Section 22 07 00 for insulation requirements for valves.

- H. Refer to Section 22 05 03 for piping materials applying to various system types.
- I. Grooved end valves shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. Grooved end shall be clean and free from indentations and projections. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.3 VALVE APPLICATIONS

- A. Valves installed in the domestic water piping system shall be Lead-Free per NSF 61, Annex G or NSF 372 requirements.
- B. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
- C. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Install globe valves for throttling, bypass, or manual flow control services.
- E. Install spring loaded check valves on discharge of water pumps.
- F. Install lever and weight, lever and spring check valves on discharge of pumps in pumped sanitary pumped storm water piping.
- G. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment.
- H. Install ball valves in domestic water systems for shut-off service.
- I. Install globe valves in domestic water systems for throttling service.
- J. Install gate valves in sanitary systems for shut-off service.
- K. Install gate valves in storm water systems for shut-off service.

END OF SECTION 220523

SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping relating to plumbing work.
9. Firestopping accessories.
10. Equipment bases and supports.

B. Related Sections:

1. Section 22 05 03 – Plumbing Pipe, Tube and Fittings.
2. Division 03 - Concrete Forming and Accessories.
3. Division 03 - Cast-In-Place Concrete.
4. Division 07 - Joint Protection.
5. Division 09 - Painting and Coating.
6. Division 07 - Requirements for roof flashing installation.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.

3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.
- D. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved by Factory Mutual Research for Property Conservation.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- F. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 5. UL - Fire Resistance Directory.

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: shall comply with ASTM E119, ASTM E814, and/or UL 263, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1-hour fire rating.
1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to UL 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. Division 01 - Submittal Procedures.
- 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. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10-inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10-inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Perform Work in accordance AWS D1.1 for welding hanger and support attachments to building structure.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with 5 years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum 5 years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - 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 damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - 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.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Carpenter & Paterson Inc.
2. Creative Systems Inc.
3. Flex-Weld, Inc.
4. Glope Pipe Hanger Products Inc.
5. Michigan Hanger Co.
6. Superior Valve Co.

B. Plumbing Piping - DWV:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
2. Hangers for Pipe Sizes 1-1/2 inches and Larger: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Vertical Support: Steel riser clamp.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 4 inches: Carbon steel, adjustable, clevis.
3. Hangers for Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
6. Vertical Support: Copper-plated, Steel riser clamp.
7. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

9. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
10. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell 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.

2.4 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
 1. Waterproofing: 5 lb./sq. ft sheet lead.
 2. Soundproofing: 1 lb./sq. ft sheet lead.
- D. Flexible Flashing: 47 mils thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-Fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-Fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic; refer to Section 07 90 00.

2.6 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 1. Thunderline Link-Seal, Inc.
 2. NMP Corporation.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:

1. B-Line Systems.
2. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.8 FIRESTOPPING

A. Manufacturers:

1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products.
6. Specified Technology, Inc.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: [Single] [Multiple] component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: [Single] [Multiple] component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of [mineral] [ceramic] fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

2.9 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

- B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- C. General:
 - 1. Furnish UL listed products or products tested by other approved independent testing laboratory.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- D. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
 - 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing or damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1, ASME B31.5, ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69, MSS SP 89.
- B. Where insulated horizontal piping occurs, provide hanger of adequate size to allow for pipe insulation to be run continuously through the hanger assembly.
- C. Support vertical piping and tubing at base and at each floor.
- D. Support horizontal piping as scheduled.
- E. Install hangers with minimum 1/2-inch space between finished covering and adjacent work.
- F. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- G. Maximum spans below were taken from MSS SP-69 for water service and from model plumbing codes. Most restrictive piping and spacing dimensions are shown.
- H. Install hangers for CAST-IRON SOIL piping with the following maximum horizontal spacing and minimum rod diameters:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
1½, 2	5	3/8
3	5	1/2
4, 5	5	5/8
6	5	3/4
8 - 12	5	7/8

- 1. Install supports for vertical cast-iron soil piping every 15 feet.

- I. Install hangers for STEEL piping with the following maximum horizontal spacing and minimum rod diameters:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
½ - 1¼	7	3/8
1½	9	3/8
2	10	3/8

3	11	1/2
4	12	5/8
6	12	3/4
8 - 12	12	7/8

1. Install supports for vertical steel piping every 15 feet.

- J. Install hangers for COPPER tubing with the following maximum horizontal spacing and minimum rod diameters:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
½ - 1¼	5	3/8
1½, 2	6	3/8
2½	8	1/2
3, 4, 5	10	1/2
6	10	5/8
8	10	3/4

1. Install supports for vertical copper tubing every 10 feet (3 m).

- K. Support horizontal CPVC piping as scheduled below:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
½ - 1	3	3/8
1¼, 2	4	3/8
2½, 3	4	1/2
4, 5	4	5/8
6	4	3/4
8	4	3/4

1. Install vertical supports for CPVC piping every 5 ft for piping 1" and smaller and every 6 ft for 1¼" and larger

- L. Install hangers for DWV PVC piping with the following maximum horizontal spacing and minimum rod diameters:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
½ - 1	3	3/8
1¼, 2	4	3/8
2½, 3	4	1/2
4, 5	4	5/8
6	4	3/4
8	4	3/4

1. Install supports for vertical PVC piping every 48 inches.
- M. Place hangers within 12 inches of each horizontal elbow.
- N. Use hangers with 1-1/2-inch minimum vertical adjustment.
- O. Support horizontal cast iron pipe adjacent to each hub.
- P. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- Q. Support piping and tubing not listed above per MSS SP-69 and manufacturer's written instructions.
- R. Prime coat exposed steel hangers and supports. Refer to Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- S. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.6 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls and floors.

- B. Flashing for roof penetrations shall be provided by the roofing contractor.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36-inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor, shower and/or mop sink drains watertight to adjacent materials.
- E. Adjust storm collars tight to pipe with bolts, caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and caulk [airtight]. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install chrome plated steel or stainless-steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.
- B. Fire Rated Surface:
 - 1. Seal opening at rated floor, wall, partition, ceiling, and/or roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1-inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
- C. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall, partition, floor, ceiling, and/or roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.

- b. Size sleeve allowing minimum of 1-inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
- 2. Install wall escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
- 3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
- 4. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, data rooms and. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.9 FIELD QUALITY CONTROL

- A. Division 01 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

- A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

- A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION 220529

SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Sections:

1. Division 09 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

B. National Fire Protection Association:

1. NFPA 99 - Standard for Health Care Facilities.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

- A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.
- B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 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.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 EXTRA MATERIALS

- A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two containers of spray-on adhesive.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
- B. Plastic Tags:
 - 1. Laminated three-layer plastic with engraved letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.

- C. Metal Tags:
 - 1. Aluminum with stamped letters; tag size minimum 1½ inches diameter with finished edge.
- D. Information Tags:
 - 1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- E. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inches Outside Diameter of Insulation or Pipe: ½ inch-high letters.
 - 2. 2½ to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
 - 3. Over 6 inches Outside Diameter of Insulation or Pipe: 2-inch-high letters.
- B. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.
- C. Provide stencil labeling for exterior piping applications only.

2.4 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1; "Scheme for the Identification of Piping Systems"
- B. Pipe markers installed above ceiling in return air plenums shall be plenum rated.
- C. Plastic Pipe Markers:
 - 1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- D. Plastic Tape Pipe Markers:
 - 1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Plastic Underground Pipe Markers:
 - 1. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mils thick, manufactured for direct burial service.

2.5 CEILING TACKS

- A. Description: Steel with 3/4-inch diameter color-coded head.
- B. Color code as follows:

1. Plumbing valves: Green.

2.6 LABELS

- A. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

- A. Lockout Hasps:

1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

- B. Valve Lockout Devices:

1. Steel device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 INSTALLATION

- A. Apply stencil painting in accordance with Division 09.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- G. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- H. Identify control panels and major control components outside panels with plastic nameplates.
- I. Identify valves in main and branch piping with tags.
- J. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction, and pressure. 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.

- K. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 220553

SECTION 220700 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

B. Related Sections:

1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
2. Division 09 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.2 REFERENCES

A. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C450 - Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.
4. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
5. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
6. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
7. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
8. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
9. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
11. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

- B. National Fire Protection Association:
 - 1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- C. Underwriters Laboratories Inc.:
 - 1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Division: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Division 01: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.8 FIELD MEASUREMENTS

- A. Verify all field measurements prior to fabrication.

1.9 WARRANTY

- A. Division 01: Product warranties and product bonds.
- B. Furnish one year minimum.
- C. Furnish five-year manufacturer warranty for manmade fiber.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:

- 1. CertainTeed.
- 2. Knauf.
- 3. Johns Manville.
- 4. Owens-Corning.

- B. Manufacturers for Closed Cell Elastomeric Insulation Products:

- 1. Aeroflex. Aerocell.
- 2. Armacell, LLC. Armaflex.
- 3. Nomaco. K-flex.

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.

- 1. Thermal Conductivity: 0.27 at 75 degrees F.
- 2. Operating Temperature Range: 0 to 850 degrees F.
- 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
- 4. Jacket Temperature Limit: minus 20 to 150 degrees F.

- B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation.

- 1. Thermal Conductivity: 0.27 at 75 degrees F.
- 2. Operating Temperature Range: 0 to 850 degrees F.

2.3 PIPE INSULATION JACKETS

- A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
- B. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1784, one-piece molded type fitting covers and sheet material, off-white color.
 2. Thickness: 15 mils.
 3. Connections: Pressure sensitive color matching vinyl tape.

2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum or stainless-steel jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.
- E. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- F. Adhesives: Compatible with insulation.
1. Indoor Vapor Retarder Finish:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.5 EQUIPMENT INSULATION

- A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
1. Thermal Conductivity: 0.24 at 75 degrees F.
 2. Operating Temperature Range: 0 to 450 degrees F.
 3. Density: 1.65 pound per cubic foot.
- B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.
1. Thermal Conductivity: 0.24 at 75 degrees F.
 2. Operating Temperature Range: 0 to 450 degrees F.
 3. Density: 3.0 pound per cubic foot.
 4. Jacket Temperature Limit: minus 20 to 150 degrees F.

1.1 EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Equipment Jacket:

1. Product Description: ASTM D1785, sheet material, off-white color.
 2. Minimum Service Temperature: -40 degrees F.
 3. Maximum Service Temperature: 150 degrees F.
 4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
 5. Thickness: 30 mil.
 6. Connections: Brush on welding adhesive with VOC content of 50 g/l according to CFR 59, Subpart D (EPA Method 24).
- B. Aluminum Equipment Jacket:
1. ASTM B209.
 2. Thickness: 0.020-inch-thick sheet.
 3. Finish: Embossed.
 4. Joining: Longitudinal slip joints and 2-inch laps.
 5. Fittings: 0.02-inch-thick die shaped fitting covers with factory attached protective liner.
 6. Metal Jacket Bands: 3/8-inch-wide; 0.015-inch-thick aluminum. 0.020-inch-thick stainless steel.
- C. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.
- D. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
- E. Field Applied Glass Fiber Fabric Jacket System:
1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
 2. Glass Fiber Fabric:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Blanket: 1.0 lb/cu ft density.
 3. Indoor Vapor Retarder Finish:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Vinyl emulsion type acrylic, compatible with insulation, black white color.

1.2 EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12-inch centers.
- D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- E. Adhesives: Compatible with insulation.

1.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
 - 1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-97.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
 - c. Marathon Industries, Inc.; 290.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 - 2. calculated per 40 CFR 59, Subpart D (EPA Method 24).
- D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacturers:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. Marathon Industries, Inc.; 225.
 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. Marathon Industries, Inc.; 225.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. Speedline Corporation; Speedline Vinyl Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).

1.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content that meets the requirement of the South Coast Air Quality Management District Rule #1168. VOC limits to be per amendment date 1/7/05.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. Marathon Industries, Inc.; 590.
 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. Marathon Industries, Inc.; 501.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Manufacturers:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.
 6. For outdoor aluminum finish, use 60-39 mastic.

1.5 SEALANTS

- A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products - Manufacturers:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 2. Joint Sealant for Polystyrene Products - Manufacturers:
 - a. Childers Products, Division of ITW; CP-70.

- b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
 - c. Marathon Industries, Inc.; 405.
 - 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 4. Permanently flexible, elastomeric sealant.
 - 5. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 6. Color: White or gray.
 - 7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:
- 1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: Aluminum.
 - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
- 1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-76.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: White.
 - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).

1.6 FIELD APPLIED FABRIC – REINFORCING MASH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Manufacturers:
 - a. Vimasco Corporation; Elastafab 894.
 - B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
 1. Manufacturers:
 - a. Childers Products, Division of ITW; Chil-Glas No. 5.
 - C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.
 1. Manufacturers:
 - a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.
- 1.7 FIELD-APPLIED CLOTHS
- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.
 1. Manufacturers:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.
- 1.8 SECUREMENTS
- A. Bands:
 1. Manufacturers:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015-inch-thick, 3/4-inch-wide with closed seal.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 3/4-inch-wide with closed seal.
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
 5. Copper clad annealed steel wire having a minimum 16-gauge thickness.
 - B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
 - a. Manufacturers:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Manufacturers:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy.
 1. Manufacturers:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.

1.9 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC per ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024-inch-thick, minimum 1 by 1-inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Division 01: Coordination and project conditions.
- B. Verify piping and or equipment has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Install insulation continuously through all hanger assemblies.
- C. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. **Refer to Division 07 for penetrations of assemblies with fire resistance rating greater than one hour.**
- D. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- E. Glass Fiber Board Insulation
 - 1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 - 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

- F. Hot Piping Systems less than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.
- G. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
- H. Insulation Terminating Points:
1. Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the control valve.
 2. Condensate Piping: Insulate entire piping system and components to prevent condensation.
- I. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
 2. Miter joints at elbows.
 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 4. When application requires multiple layers, apply with joints staggered.
 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.
- K. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum or stainless-steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.
- L. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

- M. Prepare pipe insulation for finish painting. Refer to Division 09.

3.3 INSTALLATION - EQUIPMENT

- A. Factory Insulated Equipment: Do not insulate.
- B. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- D. Equipment Containing Fluids Below Ambient Temperature:
 - 1. Insulate entire equipment surfaces.
 - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 4. Finish insulation at supports, protrusions, and interruptions.
- E. Equipment Containing Fluids 140 degrees F or Less:
 - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
 - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 - 3. Finish insulation at supports, protrusions, and interruptions.
- F. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.
- G. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.
- H. Cover insulation with aluminum jacket.
- I. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- J. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- K. Prepare equipment insulation for finish painting. Refer to Division 09.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

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

3.5 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS (inches)
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches and smaller	1.0
		1-1/2 inches and larger	1.5

Domestic Hot Water Supply and Recirculation systems with domestic water temperature maintenance cable	P-1	1 inch and smaller	1.0
		1-1/4 inches to 2 inches	1.5
		2-1/2 inches and larger	2.0
Domestic Cold Water	P-1 or P-2	1-1/4 inches and smaller	0.5
		1-1/2 inches and larger	1.0

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS (inches)
Storm Piping (horizontal above ground within building)	P-1 or P-2	All sizes	1.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS (inches)
Roof Drain Bodies	E-2	1.0
Domestic Hot Water Storage Tanks	E-1, E-2	2.0

END OF SECTION 220700

DIVISION 23
HEATING VENTILATING AND AIR CONDITIONING

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1: GENERAL

1.1 RELATED PROVISIONS

- a. The requirements of the general conditions and of Division 01 apply to that portion of the work specified in this section.
- b. These specifications and the accompanying drawings shall include the furnishing of all labor, tools, materials, fixtures, transportation, appurtenances and service necessary and incidental to the installation of a complete and operative system as indicated and intended on the Drawings and as herein specified.
- c. Contractor shall coordinate the work and equipment of this division with the work and equipment specified elsewhere in order to assure a complete and satisfactory installation. Work such as excavation, backfill, concrete, flashing, etc., which is required by the work of this Division of the Specifications, shall be provided by this Division unless otherwise indicated.
- d. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

1.2 DESCRIPTION OF THE WORK:

- a. Work included under this Division includes installation of a new cooling and heating system and associated electrical system and controls system. The systems shall be installed complete, with boilers, piping, chiller, pumps and auxiliaries as hereinafter called for. Miscellaneous items including conduits, concrete slab, etc., are to be provided as indicated.
- b. It shall be the responsibility of the Contractor to provide a complete and operating system according to the true intent and meaning of the plans and specifications and all pipe, controls and equipment, etc.

1.3 DEFINITION

- a. The word "Contractor" as used in this Section of the Specifications refers to the HVAC Contractor unless specifically noted otherwise. The word "provide" means furnish, fabricate, complete, install, erect, including labor and incidental materials, necessary to complete in place and ready for operation or use the items referred to or described herein, and/or as shown or referred to on the Contract Drawings.

1.4 HVAC CONTRACTOR'S QUALIFICATIONS

- a. It is assumed that the contractor has had sufficient general knowledge and experience to anticipate the needs for a construction of this nature. The contractor shall furnish all items required to complete the construction in accordance with

reasonable interpretation of the intent of the Drawings and Specifications. Any minor items required by Code, law or regulations shall be provided whether or not specified or specifically shown.

- b. All work must be done by first class and experienced mechanics properly supervised, and it is understood that the Engineer has the right to stop any work that is not being properly done and has the right to demand that any incompetent workman be removed from the job and a competent workman be substituted therefor.
- c. All work must be done in strict accordance with standards of AME, ASHRAE and the building laws of all character in force in the locality where the apparatus is being installed. All work must also be in accordance with rules and regulations of the National Board of Fire Underwriters.

1.5 DUTIES OF CONTRACTOR

- a. Contractor is responsible for familiarizing himself with the details of the construction of the building. Work under these specifications installed improperly or which requires changing due to improper reading or interpretation of building plans shall be corrected and changed as directed by Engineer without additional cost to the Owner.
- b. Contractor shall leave the premises in a clean and orderly manner upon completion of work and shall remove from premises all debris that has accumulated during the progress of the work. The HVAC Contractor shall have the permanent HVAC systems in sufficient readiness for furnishing temporary climatic control at the time the building is enclosed. The HVAC systems control shall maintain climatic control throughout the enclosed portion of the building sufficient to allow completion of the interior finishers of the building. A building shall be considered enclosed when it has windows installed and when doorways and other openings have protection which will provide reasonable climatic control. The appropriate climatic condition shall be jointly determined by the Contractor and the Architect. Use of the equipment in this manner shall in no way affect the warranty requirements of the Contractor.

1.6 CODES, RULES, PERMITS AND FEES

- a. The contractor shall give all necessary notices, obtain all permits and pay all government sales taxes, fees and other costs including utility connections or extension, in connection with his work; file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required certificates for inspection for his work and deliver same to the Architect before request for acceptance and final payment for the work.
- b. The contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus, ordinances, rules and regulations as required to complete the project in accordance with the intent of the drawings.
- c. All materials furnished, and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of all governmental departments having jurisdiction.

1.7 SURVEYS AND MEASUREMENTS

- a. The contractor shall base all measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at the site and check correctness of same as related to the work.
- b. Should the contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and Specifications, he shall notify the Architect and shall not proceed with his work until he has received instructions from the Architect.

1.8 PLANS

- a. Except where dimensions are shown, mechanical plans are diagrammatic; see Architectural drawings for building dimensions and locations of windows, doors, ceiling diffusers, lights, etc. The plans are not intended to show each and every fitting, valve, pipe or pipe hanger, or a complete detail of all the work to be done, but are for the purpose of illustrating the type of system, pipe and duct sizes, etc. and special conditions considered necessary for the experienced mechanic to take off his material and lay out his work. Contractor shall be responsible for taking such measurements as may be necessary at the job and adapting his work to the local conditions.

1.9 DRAWINGS AND SPECIFICATIONS

- a. Plans are diagrammatic, and it sometimes occurs that conditions exist in buildings which require certain changes in drawings and specifications. In event that such changes are necessary, the same are to be made by Contractor without expense to the Owner, provided however, that such changes, do not require furnishing more material or performing more labor than the true intent of the drawings and specifications demand.
- b. It is understood that while the drawings are to be followed as closely as circumstances will permit, the Contractor is held responsible for the installation of the system according to the true intent and meaning of the drawings. Anything not entirely clear on the drawings or in the specifications will be fully explained if application is made to the Engineer. Should however, conditions arise where in the judgment of the Contractor certain changes would be advisable. Contractor will communicate with Engineer and secure approval of the changes before going ahead with the work.
- c. The electrical and mechanical systems for this job have been designed on the basis of the mechanical equipment listed or data given herein or on the drawings. It shall be the responsibility of the Contractor to determine that the electrical service outlets, wiring, conduit and all overcurrent protective and safety devices furnished are adequate to meet Code Requirements for the equipment which he proposes to use. Changes required in the electrical system to accommodate the proposed mechanical equipment shall be worked out and the details submitted for approval. The cost of

making the necessary changes to the electrical system shall be the responsibility of the Contractor.

1.10 SHOP DRAWINGS

- a. Refer to Division 01.
- b. All items submitted to Architect for review shall bear stamp or notation indicating contractor's prior review and approval.
- c. Any Electrical or other changes required by substituted equipment to be made at no change in contract price.
- d. Submit manufacturer's certified performance data for all equipment.
- e. Coordinate installation drawings with other parts of the work, whether specified in this Division or other Divisions.
- f. Approval of shop drawings by the Engineer shall not relieve the Contractor from his obligation to provide equipment, control, and operation to the true intent of plans and specifications.
- g. The Contractor shall submit to the Engineer, within ten (10) days after approval of bids by the owner, a list indicating the manufacturer of all equipment and materials which he proposes to use. After that date, no substitution will be approved, and all items shall be as specified.

1.11 SCAFFOLDING, RIGGING, HOISTING:

- a. This contractor shall furnish all scaffolding rigging, hoisting, and services necessary to erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.12 FOUNDATIONS, SUPPORTS, PIERS, ATTACHMENTS:

- a. Contractor shall furnish and install all necessary foundations, supports, pads, bases and piers required for all air conditioning equipment, piping, pumps, tanks, compressors, and for all other equipment furnished under this contract.

1.13 SLEEVES AND OPENINGS:

- a. Contractor must have an experienced mechanic on the job before concrete slab floors or concrete masonry walls are poured or built into place, whose duty it shall be to locate exact positions of any and all holes necessary for future installation of his pipe work, ducts or equipment. Where pipes pass through concrete or masonry walls or floors, steel pipe sleeves shall be furnished. These shall be the same length as wall thickness and shall extend 1/2" above finished floors. Pipe sleeves in equipment room floors shall extend 3" above refinished floor. Pipe sleeves in equipment room floors shall extend 3" above finished floor. Sleeves shall be placed in position by this Contractor.

- b. This Contractor shall arrange for proper openings in the building to admit his equipment. If it becomes necessary to cut any portion of building to admit his equipment, portions cut must be restored to their former condition by this Contractor.
- c. This Contractor will provide duct openings or chases in masonry or concrete; however, it is this Contractor's responsibility to advise exact dimensions, shape and locations of openings required in sufficient time for the Contractor to make necessary provisions. This Contractor shall be responsible for correct size and location of each opening for his equipment through these openings.
- d. Wall openings that require a fire or smoke damper shall be made as nearly possible to the damper or duct size so that an angle frame can close the opening entirely.
- e. Where pipes or ducts penetrate floors or partitions which are fire or smoke barriers, the integrity of the barrier shall not be compromised by such penetration.

1.14 CUTTING AND PATCHING:

- a. The Contractor shall do all cutting, fitting and patching as required to install piping and equipment except openings through the roof shall be provided by the General Contractor. Patching shall be done by mechanics skilled in the various trades and work shall match the existing work.
- b. All exposed openings in walls and floors for piping shall be core drilled. Cutting of holes by hand will not be allowed.
- c. Provide all required protection including but not limited to, welding blankets, dust covers, shoring bracing and supports to maintaining structural integrity, safety and cleanliness of the work.

1.15 EXCAVATION AND BACKFILLING:

- a. All excavation and backfilling, puddling and tamping required to properly install work under this contract shall be done by this Contractor.
- b. Trenches shall be on an even grade and firmly packed to form a solid foundation for laying piping. The Contractor is cautioned to comply with the North Carolina Department of Labor requirements concerning shoring for excavations.
- c. Backfill shall be clear of rocks and trash. Backfilling shall be water tamped so as to provide firm footing for finish work, and shall be maintained at proper level for duration of the Contract. No backfilling shall be done until work to be covered has been inspected. Excessive excavation material shall be deposited on site and leveled as directed by the engineer.

1.16 POURED IN PLACE CONCRETE WORK:

- a. Furnish and install all concrete work required for the construction of anchors, guide bases and elsewhere as indicated on the Drawings. Refer to appropriate Section in Division 3 for specification requirements.

1.18 STORAGE OF MATERIALS:

- a. Equipment, ductwork, piping, and other equipment stored on site shall be protected from mud, dust, debris, weather, vermin, and construction traffic.
- b. Equipment, ductwork, piping, and other equipment shall be capped or otherwise covered to prevent water, dust, and debris intrusion. Cellophane membrane may be used for duct and equipment with care taken to maintain the seal integrity. Covering shall be replaced if seal is disturbed. Covering shall be removed only when necessary.
- c. Where pipe or ductwork becomes damaged by rust, dirt, dust, mud, or construction debris, it must be thoroughly cleaned and prepared to a like-new condition before installation.
- d. Porous materials such as duct liner and insulation that become saturated with water shall be discarded and replaced.
- e. Any equipment and/or materials affected (including aesthetically) as a result of improper storage shall be cleaned or replaced at contractor expense.

PART 2: PRODUCTS

2.1 MATERIALS

- a. Provide equipment complete with all components and accessories necessary to its satisfactory operation.
- b. Listing of a manufacturer's name in this Division does not infer conformity to all requirements of the Contract Documents, nor waive requirements thereof.

PART 3: EXECUTION

3.1 BELT DRIVES

- a. V-belt drives shall be rated at not less than 200% of nominal motor horsepower.
- b. Motor sheaves shall be fixed pitch type.
- c. Scheduled fan static pressures are estimated. Provide one extra drive per device as required to allow adjustment to deliver scheduled air quantities against actual system resistance.
- d. Provide guards for all belt drives not enclosed within equipment housings. Provide openings in guard at driving and driven sheaves for use of revolution counter.

3.2 MAINTENANCE AND OPERATING INSTRUCTIONS

- a. Upon completion of all work, the Contractor shall furnish a complete set of operating instructions for all equipment. Such instructions shall be diagrammatic in form on heavy white paper, suitably framed, protected with glass and hung where

directed by the owner. A preliminary draft of the instruction sheets shall be submitted to the engineer for approval before making same.

- b. Manufacturer's instruction books, card, etc., (to each individual piece of equipment furnished under this contract) shall be furnished to the owner. These shall contain instructions for the operation and maintenance of all equipment. Where such is not furnished by the manufacturer, the contractor shall give written instructions to the owner for the maintenance of the equipment involved.

3.3 DUCTS, PLENUM, ETC.

- a. As indicated on drawings, provide a system of ducts for supplying returning and exhausting air from various spaces. All details of the ductwork are not indicated and the necessary bends, offsets and transformations must be furnished whether shown or not.
- b. All sheet metal ducts, casing, plenums, etc., of sizes indicated, shall be constructed from prime galvanized sheet steel, and shall be in accordance with or equal to standards set forth in latest issue of SMACNA low velocity duct manual for gauges of materials, (2" pressure), workmanship, method of fabrication and erection.
- c. All uninsulated panels of ducts over twelve inches (12") wide shall be cross-broken, except on plenums, which shall be braced with angle iron as required to prevent breathing.
- d. All ductwork must present a smooth interior and joints must be airtight. Where there is evidence of undue leakage at the joints in low pressure ducts, they shall be sealed with cement similar to Foster 30-02.
- e. Depending upon space requirements, round or square elbows may be used as required or at the Contractors option in low velocity ducts. All elbows shall be constructed for minimum pressure drop. All elbows with an inside radius less than 3/4 the width of the duct must be fitted with multiple double thickness turning vanes.
- f. No transformations or offsets shall be made with a slope greater than (7 to 1), space conditions permitting.
- g. Where indicated on drawings, ductwork is to be lined with flexible fiberglass acoustics material weighing not less than 1 1/2 lb. per cubic foot and having a flame spread classification of not more than twenty-five (25) as listed under Underwriters Laboratories. Liner shall be applied according to SMACNA duct liner standard. Thickness shall be as indicated on the drawings.
- h. The lining shall be secured to the ductwork with a suitable adhesive and with mechanical fasteners center. Liner shall be cut such that adjacent sections of insulation butt together and are sealed with Foster 30-02 joints.
- i. All duct connections to and from all centrifugal fans or cabinets containing fans, shall be made with fabric equal to "Ventfab" as made by Ventfabrics, Inc., not less than four inches (4") long secured by peripheral iron straps holding fabric in galvanized iron, except as otherwise noted.

- j. Vertical ducts shall be supported by means of an angle iron frame riveted to the ductwork on at least two (2) sides. Horizontal runs of ductwork shall be supported on not more than 8'-0" centers as required.
- k. Manual volume and splitter dampers shall be furnished and installed where shown and where necessary for proper regulation of the air distribution. A quadrant and set screw equal to "Ventlock" #641 shall be installed for all dampers which are concealed above plaster or gypsum board ceilings, or behind the masonry construction, furnish and install concealed regulators ("Ventlock" #666) with chrome cover plate.
- l. All ductwork shall operate without chatter and vibration and shall be free from pulsations.
- m. See section 233113 for metal ductwork requirements.

3.4 ACCESS DOORS OR PANELS

- a. Provide duct access doors of approved construction at any apparatus requiring service and inspection. Doors shall suit finish in which installed.
- b. Access doors in rated walls or assemblies shall be rated as required to maintain rating of assembly. Rated access doors shall bear U.L. Label.

3.5 CLEANING DUCT SYSTEM

- a. Upon complete installation of ducts, clean entire system of rubbish, plaster, dirt, etc., before installing any outlets. After installation of outlets and connections to fans are made, blow out entire systems with all control devices wide open.

3.6 ITEMS OF ELECTRICAL EQUIPMENT

- a. All electrical work shall be done by properly licensed electrical mechanics in accordance with Division 26 of the specifications under supervision of a licensed Electrical Contractor as approved by the Architect.
- b. The Electrical Contractor shall provide all power wiring to motor starter and/or disconnect switch and from starter/disconnect switch to motor. The Mechanical Contractor shall provide all control wiring, low voltage or line voltage, as required for the operation of all mechanical equipment. All control devices such as motor starters, thermostats, switches, etc. shall be provided by the Mechanical Contractor.
- c. All motor starters shall be provided with a "hand-off-auto" switch on the starter cover.
- d. All items of mechanical equipment electrically operated shall be in complete accordance with electrical division of the specifications. Mechanical equipment, other than individually mounted motors, shall be factory prewired so that it will only be necessary to bring connections to a single set of terminals.

- e. Mechanical equipment electrical components shall all be bonded together and connected to electrical system ground.
- f. All mechanical equipment shall be U.L. listed and labeled as a complete package, not through individual components or parts. Provide required 3rd party field UL listing services as required to comply.

3.7 WARRANTY AND SERVICE

- a. Upon completion of all work, the contractor shall check the system out so that all motor bearings are greased as required and have all systems balanced. He shall be responsible for original service, of starting the system up, and providing one set of replacement filters after final acceptance.
- b. Refer to equipment specifications for specific warranty information.

3.8 INSPECTION AND ACCEPTANCE TEST

- a. The project will be checked periodically as construction progresses. The contractor shall be responsible for notifying the Engineer at least 48 hours in advance when any work to be covered up is ready for inspection. No work will be covered up until approved by the Engineer.
- b. Upon completion of erection of all equipment and work specified herein and shown approved shop drawings, and at the time designated by the engineer, the contractor shall start all apparatus, making necessary tests as directed and as specified herein, and make adjustments of all parts of all equipment before acceptance of equipment by the owner. The contractor must demonstrate to the owner, by performance, that all equipment operates as specified and meets the guarantee called for.
- c. Tests shall include satisfactory evidence that all systems operate as called for on the drawings, and that all pieces of equipment operate at specified ratings under specified operating conditions.
- d. The contractor shall furnish all fuel and power required for these purposes, and provide the proper and necessary help required to operate the system while tests are being made.
- e. All drainage piping shall be tested by filling with water to a point 10' above the underground drains or to point of discharge to grade and let stand thus filled for 3 hours.
- f. Tests on all pipe work shall be subject to the inspection of the Engineer. He shall be given 24-hours notice when a section pipe is to be tested and the test shall not be removed until permission is given by the Engineer.

3.9 AS BUILT DRAWINGS

- b. This contractor shall keep on the job at all times, a clean set of contract drawings in blueprint form. As the job progresses, any and all deviations from the arrangements, piping runs, equipment locations, etc., shown on the bid prints shall be marked on this set with red ink. These prints shall not be used for any other purpose than to be marked up as "As-Built" Drawings.

END OF SECTION 23 05 00

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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

1.3 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
 - 3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 5. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel.", AWS D1.3, "Structural Welding Code--Sheet Steel.", AWS D1.4, "Structural Welding Code--Reinforcing Steel." and ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Material: Carbon Steel
- C. Coating: Hot dipped galvanized
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

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

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Base: Plastic.
 - 2. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 3. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Bases: One or more plastic.
 - 2. Vertical Members: Two or more protective-coated-steel channels.
 - 3. Horizontal Member: Protective-coated-steel channel.
 - 4. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

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

- E. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

3.4 METAL FABRICATIONS

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

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 2”.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Freestanding and restrained spring isolators.
 - 4. Housed spring mounts.
 - 5. Spring hangers.
 - 6. Spring hangers with vertical-limit stops.
 - 7. Seismic snubbers.
 - 8. Restraining braces and cables.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

- A. The Mechanical Contractor shall be responsible for providing restraints to resist the earthquake effects on the mechanical system. The requirements for these restraints are found in the North Carolina State Building Code and ASCE 7.
- B. The Mechanical Contractor shall refer to the latest edition of the "Seismic Restraint Manual Guidelines for Mechanical System" published by SMACNA for guidelines to determine the correct restraints for sheet metal ducts, piping, and conduit, etc.
- C. The Mechanical Contractor shall retain the services of a Professional Structural Engineer registered in the State of North Carolina to design seismic restraint elements required for this project. The engineer's computations, bearing his professional seal, shall accompany shop drawings which show Code compliance. Computations and shop drawings shall be submitted for review prior to the purchasing of materials, equipment systems, and assemblies.
- D. The professional engineer retained by the Mechanical Contractor for seismic restraint calculations shall visit the job site upon completion of the seismic restraint installation. This

Engineer shall provide in writing verification of compliance with the approved seismic submittal. This verification shall bear the Engineer's professional seal. Job site inspection by other than this Engineer is not acceptable. This engineer shall also be responsible for any required special inspections and associated documentation related to seismic restraints.

E. Seismic-Restraint Loading:

1. Site Class as Defined in the NC State Building Code (Chapter 16) and ASCE 7, as determined by the project Structural Engineer of record.
2. Assigned Seismic Use Group or Building Category as Defined in the NC State Building Code (Chapter 16) and ASCE 7.
 - a. Component Importance Factor.
 - b. Component Response Modification Factor.
 - c. Component Amplification Factor.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second).
4. Design Spectral Response Acceleration at 1-Second Period.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring

- deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 - C. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
 - D. Welding certificates.
 - E. Qualification Data: For professional engineer and testing agency.
 - F. Review of the seismic design and shop drawings by the Engineer/Architect or his agent shall not relieve the Contractor of his responsibility to comply with the seismic or any other requirements of the North Carolina State Building Code, Section 1607.

1.6 QUALITY ASSURANCE

- A. The professional Engineer retained by the Mechanical Contractor for seismic restraint calculations shall visit the job site upon completion of the seismic restraint installation. This Engineer shall provide in writing verification of compliance with the approved seismic submittal. This verification shall bear the Engineer's professional seal. Job site inspection by other than this Engineer is not acceptable.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or

preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Kinetics Noise Control.
 - 2. Mason Industries.
 - 3. Vibration Eliminator Co., Inc.
 - 4. Vibration Isolation.
 - 5. Vibration Mountings & Controls, Inc.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- H. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- I. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Mason Industries.
 2. Vibration Eliminator Co., Inc.
 3. Vibration Isolation.
 4. Vibration Mountings & Controls, Inc.

2.3 SEISMIC-RESTRAINT DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Hilti, Inc.
 2. Kinetics Noise Control.
 3. Mason Industries.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- E. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- F. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.

- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.2 SUBMITTAL

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment (Note: Plastic Labels utilized in a return air plenum shall be listed and approved for use in a return air plenum):

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch-thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch-thick, and having predrilled holes for attachment hardware.

- B. Letter Color: Red.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. (Note: Plastic Labels utilized in a return air plenum shall be listed and approved for use in a return air plenum):
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or

space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.
- C. Major mechanical equipment shall include:
 - a. All AC units and heat pump units (split or packaged, water or air cooled)
 - b. Fan coil units
 - c. Fans

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:

1. Refrigerant Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
2. Drain Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; and shutoff valves. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape:
 - a. Refrigerant: 2 inches, round.
 2. Valve-Tag Color:
 - a. Refrigerant: Natural.
 3. Letter Color:
 - a. Refrigerant: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - 2. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.
- I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

- K. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- N. TAB: Testing, adjusting, and balancing.
- O. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- P. Test: A procedure to determine quantitative performance of systems or equipment.
- Q. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two sets of sample TAB report forms.
- F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.
- B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
 - C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
 - D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
 - E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
 - F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
 - G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 7.2.2 - "Air Balancing."
 - H. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.7.2.3 - "System Balancing."
- 1.6 COORDINATION
- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
 - B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
 - C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.
- B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
 - 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or

unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- M. Examine strainers for clean screens and proper perforations.
- N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- P. Examine system pumps to ensure absence of entrained air in the suction piping.
- Q. Examine equipment for installation and for properly operating safety interlocks and controls.
- R. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.

5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at indicated values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to indicated values.
- S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

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

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
1. Comply with requirements in ASHRAE 62.1-2007, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances (code required minimums must meet or exceed rates indicated on plans):
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Minus 5 to plus 10 percent.
 2. Air Outlets and Inlets: minus 10 to plus 10 percent.

3.7 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.8 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB firm who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.

- c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer, type size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
- 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat coil static-pressure differential in inches wg.

- g. Cooling coil static-pressure differential in inches wg.
 - h. Heating coil static-pressure differential in inches wg.
 - i. Outside airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outside-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btuh.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btuh.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.

- c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Number of belts, make, and size.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- I. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.9 INSPECTIONS

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
 - 2. Randomly check the following for each system:

- a. Measure airflow of at least 10 percent of air outlets.
- b. Measure water flow of at least 5 percent of terminals.
- c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
- d. Measure sound levels at two locations.
- e. Measure space pressure of at least 10 percent of locations.
- f. Verify that balancing devices are marked with final balance position.
- g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

- 1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
- 2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
- 3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
- 4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- 6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
- 7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.10 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 230700 – HVAC INSULATION

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. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Phenolic.
- 2. Fire-rated insulation systems.
- 3. Adhesives.
- 4. Mastics.
- 5. Lagging adhesives.
- 6. Sealants.
- 7. Factory-applied jackets.
- 8. Field-applied fabric-reinforcing mesh.
- 9. Field-applied cloths.
- 10. Field-applied jackets.
- 11. Tapes.
- 12. Securements.
- 13. Corner angles.

- B. Related Sections:

- 1. Division 21 Section "Fire-Suppression Systems Insulation."
- 2. Division 22 Section "Plumbing Insulation."

1.3 ACCEPTABLE MANUFACTURERS

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

- 1. Aeroflex
- 2. Armacell
- 3. Certain Teed Corp.
- 4. Johns Manville
- 5. Knauf Insulation
- 6. Owens Corning

7. Pittsburgh Corning Corp.
8. Dyplast Products

- B. Listing of manufacturers name does not guarantee approval. All equipment must meet or exceed quality and capacities of specified equipment. Final approval will be based on equipment submittals. Any manufacturer not listed but wishing to bid this project shall submit a written request 14 days prior to bid date, prior approval is required for all manufacturers not listed.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Block Insulation: ASTM C 552, Type I.
 - 2. Special-Shaped Insulation: ASTM C 552, Type III.
 - 3. Board Insulation: ASTM C 552, Type IV.
 - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory applied FSK jacket. For equipment applications, provide insulation with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- J. Mineral-Fiber, Preformed Pipe Insulation:
1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 2. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
- L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- M. Phenolic:
1. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 4. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Preformed Pipe Insulation: ASJ.

- b. Board for Duct and Plenum Applications: ASJ.
- c. Board for Equipment Applications: ASJ.

2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
 - d. Thermal Ceramics; FireMaster Duct Wrap.
 - e. 3M; Fire Barrier Wrap Products.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass and Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.

- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants: Cellular-Glass and Phenolic Products.

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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

2.7 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and

with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
- B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: Color-code jackets based on system.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 4. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Finish and thickness are indicated in field-applied jacket schedules.
 - b. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
- F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- G. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 4 mils.
 3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 6 mils.
 3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 1/2 inch wide with wing or closed seal.

2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
 - b. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030-inch-thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
 - b. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

- a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.

2.13 CORNER ANGLES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

- c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 - 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 - 7. Stagger joints between insulation layers at least 3 inches.
 - 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 - 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 - 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 - 1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 - 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
 - 1. Provide 1" foam-core insulation on all chilled water pumps. Install pump insulation per foam-core insulation manufacturer's pump insulation installation instructions. Include pump insulation installation instructions with insulation submittals.
 - 2. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

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

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

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

3.7 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.

- e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 PHENOLIC INSULATION INSTALLATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

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

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.12 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.13 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: Coat exposed outdoor flexible elastomeric insulation with two coats of manufacturer's recommended protective white coating; or cover with aluminum jacketing all exposed outdoor flexible elastomeric insulation, in lieu of paint.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

- D. Do not field paint aluminum or stainless-steel jackets.

3.14 FIELD QUALITY CONTROL

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

3.15 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply, return, and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Outdoor, concealed supply and return.
 - 4. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Indoor, exposed return air in air conditioned, occupied spaces
 - 4. Exhaust ductwork.
 - 5. Factory-insulated flexible ducts.
 - 6. Factory-insulated plenums and casings.
 - 7. Flexible connectors.
 - 8. Vibration-control devices.
 - 9. Factory-insulated access panels and doors.

3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Supply-air Ducts, concealed (installed above ceilings):
 - 1. Mineral-Fiber Blanket: 2 inches thick and installed R-6.0.
- B. Return Air Ducts, concealed (installed above ceilings):
 - 1. Mineral-Fiber Blanket: 2 inches thick and installed R-6.0.
- C. Exposed Return Ductwork in Air Conditioned, Occupied Spaces, and Exhaust Air Ductwork:
 - 1. None.
- D. Exposed Supply and Return Ductwork exposed in Air-Conditioned Utility Spaces (Conditioned Mechanical Rooms or Mechanical Rooms used as Return Air Plenums) and Exposed in Non-Air Conditioned Spaces (Boiler Rooms, et. Al):
 - 1. Mineral-Fiber Board Insulation: 2 inches thick and installed R-6.0.
- E. Outside-Air Ducts:
 - 1. Mineral-Fiber Blanket: 2 inches thick and installed R-6.0.

3.17 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- B. Supply-air, return-air and outside-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 3 inches and 3-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

3.18 PIPING INSULATION SCHEDULE, GENERAL

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

3.19 INDOOR PIPING INSULATION SCHEDULE

A. Condensate, Cold Water Make-up and Equipment Drain Water:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 3/4 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. Insulation shall be installed per the manufacturer's recommendations.

3.20 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be as recommended by the manufacturer.

3.21 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.
- B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.
- C. Condenser-Water Supply and Return, All Sizes: Cellular glass, 2 inches thick.
- D. Heating-Hot-Water Supply and Return, All Sizes: Cellular glass, 2 inches thick.
- E. Dual-Service Heating and Cooling, All Sizes: Cellular glass, 2 inches thick.

3.22 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts, Plenums, and Piping, concealed (installed above ceilings) and Exposed in Air-Conditioned Occupied Spaces:
 1. None.
- D. Ducts, Plenums, and Piping, Exposed in Air-Conditioned Utility Spaces (Conditioned Mechanical Rooms and Mechanical Rooms used as Return Air Plenums):
 1. 8-ounce canvas with lagging adhesive.

E. Ducts, Plenums, and Piping, Exposed in Non-Air-Conditioned Spaces (Boiler Rooms, et. al.):

1. PVC: 20 mils thick (N/A if installed in a return air plenum).
2. Aluminum, Smooth: 0.016 inch thick.

F. Equipment, concealed (installed above ceilings):

1. None.

G. Equipment, Exposed (all applications):

1. PVC: 20 mils thick (N/A if installed in a return air plenum)
2. Aluminum, Smooth: 0.016 inch thick.

3.23 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. PVC: 20 mils thick.
2. Aluminum, Smooth: 0.016 inch thick.

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Smooth: 0.016 inch thick.

E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Smooth with 0.032 inch thick.

F. Piping, Exposed:

1. PVC, Color-Coded by System: 20 mils thick.
2. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 23 07 00

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-407C:
 - 1. Suction Lines for Air-Conditioning Applications: 230 psig.
 - 2. Suction Lines for Heat-Pump Applications: 380 psig.
 - 3. Hot-Gas and Liquid Lines: 380 psig.
- B. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.3 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.4 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
 2. Core: Removable ball-type check valve with stainless-steel spring.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Copper spring.
 5. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24 V ac coil.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
 8. Manual operator.
- F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 450 psig
- H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- I. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.

2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: as indicated on the drawings.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: tons as indicated on the drawings
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.

4. Maximum Operating Temperature: 275 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 1-1/2 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 4. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- G. Safety-Relief-Valve Discharge Piping:
 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 1-1/2 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 4. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.

- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping in accordance with the equipment manufacturer's recommendations.
- C. Install refrigerant piping according to ASHRAE 15.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping adjacent to machines to allow service and maintenance.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

- A. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- B. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2: Maximum span, 60 inches minimum rod size, 1/4 inch
 - 2. NPS 5/8 Maximum span, 60 inches minimum rod size, 1/4 inch
 - 3. NPS 1 Maximum span, 72 inches minimum rod size, 1/4 inch
 - 4. NPS 1-1/4 Maximum span, 96 inches minimum rod size, 3/8 inch
 - 5. NPS 1-1/2 Maximum span, 96 inches minimum rod size, 3/8 inch
 - 6. NPS 2 Maximum span, 96 inches minimum rod size, 3/8 inch
 - 7. NPS 2-1/2 Maximum span, 108 inches minimum rod size, 3/8 inch
 - 8. NPS 3 Maximum span, 10 feet minimum rod size, 3/8 inch
 - 9. NPS 4 Maximum span, 12 feet minimum rod size, 1/2 inch
- C. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

- a. Fill system with nitrogen to the required test pressure.
- b. System shall maintain test pressure at the manifold gage throughout duration of test.
- c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
- d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Verify that compressor oil level is correct.
 2. Open compressor suction and discharge valves.
 3. Open refrigerant valves except bypass valves that are used for other purposes.
 4. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 233300 – AIR DUCT ACCESSORIES

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. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Turning vanes.
12. Remote damper operators.
13. Duct-mounted access doors.
14. Flexible connectors.
15. Flexible ducts.
16. Duct accessory hardware.

- B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.
- C. Source quality-control reports.
- D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G90.
 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304.

- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. American Warming and Ventilating; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff; a division of PCI Industries, Inc.
 - 6. Ruskin Company.
 - 7. SEMCO Incorporated.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1500 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Maximum Leakage: 40" wide, 1% of max. flow.
- F. Frame: 0.09-inch- thick extruded aluminum, with welded corners.
- G. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050-inch- thick aluminum sheet with sealed edges.
- H. Blade Action: Parallel.
- I. Blade Seals: Extruded vinyl, mechanically locked.
- J. Blade Axles:
 - 1. Material: Aluminum.
 - 2. Diameter: 0.20 inch.
- K. Tie Bars and Brackets: Aluminum.
- L. Return Spring: Adjustable tension.
- M. Bearings: Steel ball or synthetic pivot bushings.

N. Accessories: (as noted on plans or required by installation)

1. Electric actuators.
2. Chain pulls.
3. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
4. Screen Mounting: Rear mounted.
5. Screen Material: Aluminum.
6. Screen Type: Bird or Insect (as noted on drawings)
7. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff; a division of PCI Industries, Inc.
6. Ruskin Company.
7. SEMCO Incorporated.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 1000 fpm..

D. Maximum System Pressure: 2-inch wg.

E. Maximum Leakage: 40" wide, 1% of max. flow.

F. Frame: 0.09-inch- thick extruded aluminum, with welded corners.

G. Blades:

1. Multiple, 0.025-inch- thick, roll-formed aluminum.
2. Maximum Width: 2 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

H. Blade Seals: Vinyl.

I. Blade Axles: ½" diameter synthetic

J. Tie Bars and Brackets:

1. Material: Aluminum.
 2. Rattle free with 90-degree stop.
- K. Return Spring: Adjustable tension.
- L. Bearings: Synthetic.
- M. Accessories: (as noted on plans or required by installation)
1. Adjustment device to permit setting for varying differential static pressure.
 2. Counterweights and spring-assist kits for vertical airflow installations.
 3. Flange on intake.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
2. Suitable for horizontal or vertical applications.
3. Frames:
 - a. Hat-shaped, galvanized-steel channels, 16-gauge minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 16-gauge thick.
5. Blade Axles: Galvanized steel.
6. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Tie Bars and Brackets: Galvanized steel.

2.5 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. METALAIRE, Inc.
 - 4. Metal Form Manufacturing, Inc.
 - 5. Nailor Industries Inc.
 - 6. Ruskin Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 - 1. Hat shaped.
 - 2. Galvanized-steel channels, 0.064 inch thick.
 - 3. Mitered and welded corners.
- D. Blades:
 - 1. Multiple blades with maximum blade width of 8 inches, airfoil design.
 - 2. Opposed-blade design.
 - 3. Galvanized steel.
 - 4. 14-gauge thickness.
 - 5. Blade Edging: Closed-cell neoprene edging.
 - 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
 - 1. Stainless-steel sleeve.
 - 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.

4. Pottorff; a division of PCI Industries, Inc.
 5. NCA Manufacturing.
 6. Ruskin Company.
- B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 20-gauge galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.052 or 0.138-inch-thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links (unless noted otherwise).

2.7 CEILING DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. METALAIRE, Inc.
 3. Nailor Industries Inc.
 4. NCA Manufacturing.
 5. Ruskin Company.
- B. General Requirements:
1. Labeled according to UL 555C by an NRTL.
 2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.

- E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links (unless noted otherwise).

2.8 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. NCA Manufacturing.
 - 5. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- D. Blades: Roll-formed, horizontal, interlocking, 16-gauge thickness, galvanized sheet steel. Blades shall be true airfoil blades.
- E. Leakage: Class I.
- F. Rated pressure and velocity to exceed design airflow conditions.
- G. Mounting Sleeve: Factory-installed, 20-gauge thickness, galvanized sheet steel; length to suit wall or floor application.
- H. Damper Motors: two-position action, electric 120V or 24V as noted on the plans.
- I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." and Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

7. Electrical Connection: 120V or 24V as noted on the drawings.

J. Accessories: (as indicated on the drawings)

1. Auxiliary switches for or position indication.
2. Momentary test switch, damper mounted.

2.9 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. NCA Manufacturing.
5. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links (unless noted otherwise).

G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

H. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Leakage: Class I.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 20-gauge thickness, galvanized sheet steel; length to suit wall or floor application.

L. Master control panel for use in dynamic smoke-management systems.

M. Damper Motors: Modulating or two-position action.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." and Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 120V or 24V as noted on the drawings.

O. Accessories: (as indicated on the drawings)

1. Auxiliary switches for position indication.
2. Momentary test switch, damper mounted.

2.10 CORRIDOR DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. Greenheck Fan Corporation.
 3. Nailor Industries Inc.
 4. NCA Manufacturing.
 5. Ruskin Company.
- B. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-1/2-hour rating by an NRTL.
- C. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links (unless noted otherwise).
- D. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- E. Frame: Multiple-blade type; fabricated with roll-formed, 16-gauge galvanized steel; with mitered and interlocking corners.
- F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- G. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

- H. Damper Motors: Modulating or two-position action.
- I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." and Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 120V or 24V as noted on the drawings.

2.11 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 30 inches wide and double wall for larger dimensions.

2.12 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pottorff; a division of PCI Industries, Inc.
 - 2. Ventfabrics, Inc.

3. Young Regulator Company.
 4. Metropolitan.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed, 3/4 inches deep.
- F. Wall-Box Cover-Plate Material: Stainless steel.

2.13 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Ductmate Industries, Inc.
 3. Greenheck Fan Corporation.
 4. McGill AirFlow LLC.
 5. Nailor Industries Inc.
 6. Pottorff; a division of PCI Industries, Inc.
 7. Ruskin
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
 2. Door: Single wall, 12-gauge.

3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 2" to 10" for positive pressure and -4" to -10" for negative pressure.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.14 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 26 oz./sq. yd.
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 1. Minimum Weight: 24 oz./sq. yd.
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.15 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Noninsulated, 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, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 250 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2007.
- D. Flexible Duct Connectors:
 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or nylon strap in sizes 3 through 18 inches, to suit duct size.

2.16 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing and manufacturer's instructions.
- H. Connect ducts to duct silencers with flexible duct connectors.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At drain pans and seals.
 - 4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 5. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 6. Control devices requiring inspection.
 - 7. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand / Visual Access: 12 by 12 inches.

3. Head and Hand Access: 18 by 12 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Connect terminal units to supply ducts directly or with maximum 6-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- P. Connect diffusers or light troffer boots to ducts with maximum 48-inch lengths of flexible duct clamped or strapped in place.
- Q. Connect flexible ducts to metal ducts with approved strap and sealant.
- R. Install duct test holes where required for testing and balancing purposes.
- S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.
 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 233423 – HVAC POWER VENTILATORS

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. See fan schedule on drawings for additional requirements and specific options required for each fan.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Utility set fans.
 - 2. Centrifugal roof ventilators.
 - 3. Ceiling-mounting ventilators.
 - 4. In-line centrifugal fans.
 - 5. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck
 - 2. Loren Cook Company
 - 3. Penn Ventilation
 - 4. Twin City Fans
- B. Listing of manufacturers name does not guarantee approval. All equipment must meet or exceed quality and capacities of specified equipment. Final approval will be based on equipment submittals. Any manufacturer not listed but wishing to bid this project shall submit a written request 14 days prior to bid date, prior approval is required for all manufacturers not listed.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, wiring diagrams, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Operation and Maintenance Data: For power ventilators to include operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

- A. Description: Direct- or Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
- B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
 - 1. Housing Discharge Arrangement: Adjustable to eight standard positions.
- C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
 - 1. Blade Materials: Steel.
 - 2. Blade Type: Backward inclined (unless noted otherwise on the fan schedule).
- D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L₅₀ of 500,000 hours or L₁₀ of 100,000 hours.
- F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.5.
 - 2. Motor Pulleys: Adjustable pitch for use with motors through 10 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories: (See drawings for required accessories).
 - 1. Inlet and Outlet: Flanged.
 - 2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
 - 4. Access Door: Gasketed door in scroll with latch-type handles.
 - 5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
 - 6. Inlet Screens: Removable wire mesh.
 - 7. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
 - 8. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

9. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
 10. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
 11. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
- H. Coatings: As indicated on the drawings.
- I. Capacities and Characteristics: As indicated on the drawings.

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector for UL 762 kitchen hood exhaust fans.
 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 4. Fan and motor isolated from exhaust airstream.
- E. Accessories: (See drawings for required accessories).
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. Backdraft dampers on all roof mounted supply fans shall be motorized.
- F. Roof Curbs: Galvanized steel; welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 8 inches (unless noted otherwise).
3. Pitch Mounting: Manufacture curb for roof slope.
4. Metal Liner: Galvanized steel.
5. Burglar Bars: 1/2-inch- thick steel bars welded in place to form 6-inch squares (where indicated on the drawings).
6. Vented Curb: Unlined with louvered vents in vertical sides (where indicated on the drawings).

G. Capacities and Characteristics: As indicated on the drawings.

2.3 CEILING-MOUNTING VENTILATORS

- A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories: (See drawings for required accessories).
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 4. Motion Sensor: Motion detector with adjustable shutoff timer.
 5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
 6. Filter: Washable aluminum to fit between fan and grille.
 7. Isolation: Rubber-in-shear vibration isolators.
 8. Manufacturer's standard roof jack or wall cap, and transition fittings.
- G. Capacities and Characteristics: As indicated on the drawings.

2.4 IN-LINE CENTRIFUGAL FANS

- A. Description: In-line, direct- or belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

- C. Direct-Driven Units: Motor mounted in airstream; factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 - 3. Companion Flanges: For inlet and outlet duct connections.
 - 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 5. Motor and Drive Cover (Belt Guard): Galvanized steel.
- G. Capacities and Characteristics: As indicated on the drawings.

2.5 PROPELLER FANS

- A. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- D. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.4.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.
 - 4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - 5. Motor Pulleys: Adjustable pitch for use with motors through 10 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

7. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories: (See drawings for required accessories).

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall housing: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics: As indicated on the drawings.

2.6 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Totally enclosed, fan cooled.

2.7 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

- C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.

11. Remove and replace malfunctioning units and retest as specified above.

- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 23 34 23

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

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. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Louver face diffusers.
5. Linear slot diffusers.
6. Adjustable Bar Register
7. Fixed face registers.

- B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACCEPTABLE MANUFACTURERS

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

1. Carnes
2. METALAIRE, Inc.
3. Nailor industries
4. Price
5. Titus
6. Tuttle & Bailey
7. Krueger

- B. Listing of manufacturers name does not guarantee approval. All equipment must meet or exceed quality and capacities of specified equipment. Final approval will be based on equipment submittals. Any manufacturer not listed but wishing to bid this project shall submit a written request 14 days prior to bid date, prior approval is required for all manufacturers not listed.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- E. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Round Ceiling Diffuser:
 - 1. Devices shall be specifically designed for variable-air-volume flows.
 - 2. Material: Steel or Aluminum as indicated on the drawings.
 - 3. Finish: Baked enamel, white unless noted otherwise.
 - 4. Face Style: Three cone.
 - 5. Mounting: Duct connection.
 - 6. Pattern: Fully adjustable.
 - 7. Dampers: Radial opposed blade.
- B. Rectangular and Square Ceiling Diffusers:
 - 1. Devices shall be specifically designed for variable-air-volume flows.
 - 2. Material: Steel or Aluminum as indicated on the drawings.
 - 3. Finish: Baked enamel, white unless noted otherwise.
 - 4. Face Size: 24 by 24 inches or as indicated on the drawings.
 - 5. Face Style: Four cone.
 - 6. Mounting: As required.

7. Pattern: Fixed.
8. Dampers: Radial opposed blade.

C. Perforated Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel backpan and pattern controllers, with steel or aluminum face as indicated on the drawings.
3. Finish: Baked enamel, white unless noted otherwise.
4. Face Size: 24 by 24 inches or as indicated on the drawings.
5. Duct Inlet: Round or Square as indicated on the drawings.
6. Face Style: Flush.
7. Mounting: T-bar.
8. Pattern Controller: Adjustable with louvered pattern modules at inlet.
9. Dampers: Radial opposed blade.

D. Louver Face Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel or Aluminum as indicated on the drawings.
3. Finish: Baked enamel, white unless noted otherwise.
4. Face Size: As indicated on the drawings.
5. Mounting: As required.
6. Pattern: Four-way core style, unless noted otherwise.
7. Dampers: Radial opposed blade.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Material: Steel or Aluminum as indicated on the drawings.
2. Finish: Baked enamel, white unless noted otherwise.
3. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
4. Core Construction: Integral.
5. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
6. Frame: 1-1/4 inches wide.
7. Mounting: Concealed.
8. Damper Type: Adjustable opposed blade.
9. Accessories:
 - a. Rear-blade gang operator.
 - b. Filter.

B. Fixed Face Register:

1. Material: Steel or Aluminum as indicated on the drawings.
2. Finish: Baked enamel, white unless noted otherwise.
3. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
4. Core Construction: Integral.
5. Frame: 1 inch wide.

6. Mounting: Concealed.
7. Damper Type: Adjustable opposed blade.
8. Accessory: Filter.

2.3 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material - Shell: Steel or Aluminum as indicated on the drawings.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel, white exterior with black interior, unless noted otherwise.
5. Finish - Pattern Controller: Baked enamel, black.
6. Finish - Tees: Baked enamel, white.
7. Slot Width: As indicated on the drawings.
8. Number of Slots: as indicated on the drawings.
9. Length: as indicated on the drawings.
10. Accessories:
 - a. End caps in lay-in ceilings.
 - b. End Borders where not installed in lay-in ceilings.
 - c. Insulated plenum: By manufacturer black finish unless otherwise noted.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels,

locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting and may be connected to ducts.

1.2 SUBMITTALS

- A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier
2. Trane
3. York

2.2 EVAPORATOR-FAN UNIT

- A. Concealed Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 1. Insulation: Faced, glass-fiber duct liner.
 2. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1-2007.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
- D. Fan Motor: Multispeed.
- E. Filters: 1 inch thick, in fiberboard frames.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

- A. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed reciprocating type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 1. Refrigerant: R-410a (unless otherwise indicated on the drawings).
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Fan: Aluminum-propeller type, directly connected to motor.
- E. Motor: Permanently lubricated, with integral thermal-overload protection.
- F. Low Ambient Kit: Permits operation down to 45 deg F.
- G. Mounting Base: Polyethylene.
- H. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2007, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
 - 1. Minimum Insulation Thickness: 1/2 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- B. Install ground-mounted, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- D. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- B. Connect supply and return condenser connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
- C. Install piping adjacent to unit to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

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

- B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.
- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 81 26

DIVISION 26
ELECTRICAL

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices and terminations rated 600 V and less.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2, Type XHHW-2, Type UF and Type SO.
- C. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire and Type SO with ground wire.
- D. VFC Cable:
 - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.

2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance, Wet Location, Exposed: Type THHN/THWN-2 or XHHW-2 single conductors in raceway.
- B. Exposed Feeders Dry Location: Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type SER multi-conductor jacketed cable, Metal-clad cable, Type MC.
- C. Feeders Concealed below Concrete, below Slabs-on-Grade and Underground: Type THHN/THWN-2, single conductors in raceway.
- D. Exposed Branch Circuits subject to damage: Type THHN/THWN-2, single conductors in raceway
- E. Exposed Branch Circuit not subject to damage such as attic space: Metal-clad cable, Type MC, Nonmetallic-sheathed cable, Type NM.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC, Nonmetallic-sheathed cable, Type NM.

- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway, Underground branch-circuit cable, Type UF.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. VFC Output Circuits: Type XHHW-2 in metal conduit Type TC-ER cable.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy
 - 2. ERICO
 - 3. ILSCO.
 - 4. Thomas & Betts Corporation

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum or as noted on drawings.
 1. Bury minimum 24 inches below grade.
- C. Conductor Terminations and Connections:
 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Thermally welded connections except at test wells and as otherwise indicated.
 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 4. Connections to Structural Steel: Thermally Welded connection.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Grounding Handholes: Install a driven ground rod through bottom of handhole and set rod depth so 4 inches will extend above base of handhole. Extend No. 1/0 AWG bare tinned-copper conductor or as noted on drawings from ground rod to main ground bar in service panel. Label as “Grounding System Access Point.”

3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through bottom of handhole. Handholes shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 260526

SECTION 260529 -HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Requirements:

1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, and coordinated with each other, using input from installers of the items involved:

B. Seismic Qualification Certificates: For hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

C. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: **1.5**.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cooper B-Line
 - b. Thomas & Betts Corporation
 - c. Unistrut
 2. Material: Pre-galvanized steel.
 3. Channel Width: 1-5/8 inches minimum.
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied per MFMA-4.
 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied per MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1) Cooper B-Line, Inc.
 - 2) Hilti, Inc.
 - 3) ITW Ramset/Red Head
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.2 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. Retain "ARC" Paragraph below for corrosion resistance and for power distribution at frequencies above 60 Hz or for other special conditions.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression
 - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- H. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.

- E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: Comply with UL 514B.
- G. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- H. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R, unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, [**ferrous alloy**], Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
 - 1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- K. Gangable boxes are prohibited.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:
 - 1. NEMA 250, Type 1 or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, as applicable.
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: EMT.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or Type 4.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts.
 - c. Mechanical rooms.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 5. Damp or Wet Locations: GRC
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: ½ inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use compression steel fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 5. Change from ENT to RNC, Type EPC-40-PVC, GRC, or IMC before rising above floor.
- I. Stub-ups to Above Recessed Ceilings:
1. Use EMT for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
 - K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
 - L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
 - M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
 - N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
 - O. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
 - P. Expansion-Joint Fittings:
 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- Q. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- R. 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.
- S. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- U. Locate boxes so that cover or plate will not span different building finishes.
- V. 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.
- W. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- X. Set metal floor boxes level and flush with finished floor surface.
- Y. 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.
2. 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.
3. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

- b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Metraflex Company (The).
 - c. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. HOLDRITE.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of 50g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548.16 - SEISMIC CONTROLS

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. Restraint channel bracings.
 - 2. Restraint cables.
 - 3. Seismic-restraint accessories.
 - 4. Mechanical anchor bolts.
 - 5. Adhesive anchor bolts.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For each seismic-restraint device.
 - 1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - 3. Seismic-Restraint Details:

- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
- c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: **B**.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: **I**.
 - a. Component Importance Factor: **1.0**.
 - b. Component Response Modification Factor: **1.5**.
 - c. Component Amplification Factor: **1.0**.

2.2 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut; an Atkore International company.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc.
 2. Loos & Co., Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. TOLCO; a brand of NIBCO INC.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install cables so they do not bend across edges of adjacent equipment or building structure.

C. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

E. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- #### A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

- #### A. Perform the following tests and inspections:

1. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 2. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 3. Test to 90 percent of rated proof load of device.
- B. Seismic controls will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548.16

SECTION 260553 - IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels, including arc-flash warning labels.
8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 1. Black letters on an orange field.
 2. Legend: Indicate voltage and system or service type.

- B. Warning labels and signs shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

- A. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

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. Brady Corporation.
 - b. LEM Products Inc.
 - c. Panduit Corp.
 - d. Seton Identification Products.

- B. Self-Adhesive Labels:

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. Brady Corporation.
 - b. Ideal Industries, Inc
 - c. Panduit Corp.
2. Preprinted, 3-mil-thick, polyester flexible label with acrylic pressure-sensitive adhesive.
3. Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 - a. Nominal Size: 3.5-by-5-inch.

2.4 TAPES AND STENCILS:

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

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. Carlton Industries, LP.
 - b. Ideal Industries, Inc.

- c. Marking Services, Inc.
 - d. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP
- C. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
 - 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. Carlton Industries, LP.
 - b. Seton Identification Products.
- D. Underground-Line Warning Tape
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ideal Industries, Inc.
 - b. LEM Products Inc.
 - c. Seton Identification Products.
 - 2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

2.5 Signs

- A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.
4. 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. Carlton Industries, LP.
 - b. Marking Services, Inc.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.
4. 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. Brady Corporation.
 - b. Champion America.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. inches, minimum 1/16-inch.
 - b. For signs larger than 20 sq. inches, 1/8 inch thick.
 - c. Engraved legend with:
 - 1) White letters on blue face for 120/208V equipment;
 - 2) White letters on green face for emergency systems;
 - 3) White letters on bright red face for fire alarm system
 - 4) White letters on burgundy face for security systems;
 - 5) White letters on orange surface for telephone systems
 - 6) White letters on brown surface for data systems;
 - 7) White letters on purple surface for TV systems;
 - d. Punched or drilled for mechanical fasteners.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
3. 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. Brady Corporation.

- b. Carlton Industries, LP.
- c. emedco.

2.6 CABLE TIES

- 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. Ideal Industries, Inc.
 - 2. Marking Services, Inc.
 - 3. Panduit Corp.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- D. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- E. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- F. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 90A and 120 V to Ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase-and Voltage-Level Identification, 600 V or Less: Use industry standard colors for ungrounded service and feeder conductors.
 - a. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive, self-laminating polyester labels with the conductor or cable designation, origin, and destination.
- E. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker-tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- K. Arc Flash Warning Labeling: Self-adhesive thermal transfer vinyl labels.
1. Comply with NFPA 70E and ANSI Z535.4.
 2. Comply with Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.
- L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy, switchbox-mounted occupancy and outdoor motion sensors.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Contact Configuration: DPDT.
3. Contact Rating: 30-A inductive or resistive, 240-V ac.
4. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
7. Astronomic Time: All channels.
8. Automatic daylight savings time changeover.
9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Cooper Industries, Inc.
 2. Intermatic, Inc.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. Lutron Electronics Co., Inc.
 6. Sensor Switch, Inc.
 7. Watt Stopper.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- 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. Bryant Electric.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 6. Lutron Electronics Co., Inc.
 7. Square D.
 8. Watt Stopper.

- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag WS1:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..
 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
 4. Voltage: Dual voltage, 120 and 277 V; dual-technology type.
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
- D. Wall-Switch Sensor Tag WS2:
1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
 2. Sensing Technology: PIR.
 3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
 4. Voltage: Dual voltage, 120 and 277 V; dual-technology type.
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.5 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Corporation.
 2. General Electric Company.
 3. Square D.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 22 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
- C. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.
- D. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- E. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers for apartment units

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. SPD: Surge protective device.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard schedules for installation in panelboards.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 FIELD CONDITIONS

A. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Height: 80 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
- F. Incoming Mains Location: as indicated on plans.
- G. Phase, Neutral, and Ground Buses: Tin-plated aluminum.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum.
 - 2. Main and Neutral Lugs: Mechanical type with a lug on the neutral bar for each pole in the panelboard.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type with a lug on the bar for each pole in the panelboard.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Sub-feed Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
 - J. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 - K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or Type 2 as indicated on the plans.

2.3 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton Cutler Hammer
 2. General Electric Company
 3. Siemens
 4. Square D
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only, as indicated on the plans.

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- G. Branch Overcurrent Protective Devices: Fused switches.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Cutler Hammer
 - 2. General Electric Company
 - 3. Siemens
 - 4. Square D
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 LOAD CENTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton
 - 2. General Electric Company
 - 3. Siemens
 - 4. Square D
- B. Load Centers: Comply with UL 67.
- C. Mains: Circuit breaker or lugs only as indicated on the drawings.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Cutler Hammer.
 2. General Electric
 3. Siemens
 4. Square D
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 4. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 5. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 6. Subfeed Circuit Breakers: Vertically mounted.
 7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching lighting loads.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Shunt Trip: 120-V trip coil energized from separate circuit.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

2.7 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NECA 407.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Mount top of trim 90 inches above finished floor, 80" to highest operable device, unless otherwise noted.
- E. Mount panelboard cabinet plumb and rigid without distortion of box.
- F. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Make grounding connections and bond neutral for services and separately derived systems to ground.
- I. Install filler plates in unused spaces.
- J. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification."

- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
2. Hubbell Incorporated; Wiring Device-Kellems.
3. Leviton Manufacturing Co., Inc.
4. Pass & Seymour/Legrand (Pass & Seymour).

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
- B. Duplex Receptacles, 125 V, 15 A:
1. Description: Two pole, three wire, and self-grounding.
 2. Configuration: NEMA WD 6, Configuration 5-15R.
 3. Standards: Comply with UL 498 and FS W-C-596.

2.4 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, non-feed-through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).

2.5 USB RECEPTACLES

A. USB Charging Receptacles:

1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles: Dual, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
3. Standards: Comply with UL 1310 and USB 3.0 devices.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120V, 20 A:

1. Single Pole:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - 2) Hubbell Incorporated; Wiring Device-Kellems.
 - 3) Leviton Manufacturing Co., Inc.
 - 4) Pass & Seymour/Legrand (Pass & Seymour).
2. Two Pole:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - 2) Hubbell Incorporated; Wiring Device-Kellems.
 - 3) Leviton Manufacturing Co., Inc.
 - 4) Pass & Seymour/Legrand (Pass & Seymour).
3. Three Way:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
- 2) Hubbell Incorporated; Wiring Device-Kellems.
- 3) Leviton Manufacturing Co., Inc.
- 4) Pass & Seymour/Legrand (Pass & Seymour).

4. Four Way:

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

- 1) Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
- 2) Hubbell Incorporated; Wiring Device-Kellems.
- 3) Leviton Manufacturing Co., Inc.
- 4) Pass & Seymour/Legrand (Pass & Seymour).

C. Key-Operated Switches, 120/277 V, 20 A:

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

- a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
- b. Hubbell Incorporated; Wiring Device-Kellems.
- c. Leviton Manufacturing Co., Inc.
- d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.7 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

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

- a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
- b. Hubbell Incorporated; Wiring Device-Kellems.
- c. Leviton Manufacturing Co., Inc.
- d. Pass & Seymour/Legrand (Pass & Seymour).

B. GFCI, Non-Feed -Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.

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

- a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
- b. Hubbell Incorporated; Wiring Device-Kellems.
- c. Leviton Manufacturing Co., Inc.
- d. Pass & Seymour/Legrand (Pass & Seymour).

2.8 RESIDENTIAL DEVICES

A. Fan Speed Controls:

1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
2. Comply with UL 1917.
3. Continuously adjustable slider 1.5 A.
4. Three-speed adjustable slider, 1.5 A.

B. Combination TV and Telephone Outlet:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

2.9 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: See plans.
3. Material for Unfinished Spaces: See plans.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

2.11 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As indicated on the drawings unless otherwise indicated or required by NFPA 70 or device listing.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units, and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Enclosed controllers.
 - c. Enclosed switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann
 2. Farraz Shawmut
 3. Littelfuse

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 3. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Provide spare fuses, one of each type used on project.

3.2 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Sector; Eaton Corporation.
 - 2. General Electric Company.
 - 3. Siemens Industry, Inc.
 - 4. Square D; by Schneider Electric.
- B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate indicated fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Suitable for number, size, and conductor material.

2.3 RECEPTACLE SWITCHES

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

1. Eaton Electrical Sector; Eaton Corporation.
 2. General Electric Company.
 3. Siemens Industry, Inc.
 4. Square D; by Schneider Electric.
- B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 600-V ac; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- C. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 600-V ac; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Sector; Eaton Corporation.
 2. General Electric Company.
 3. Siemens Industry, Inc.
 4. Square D; by Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Alarm Switch: One contact that operates only when circuit breaker has tripped.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

SECTION 264313 - SURGE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the latest editions of the following standards:
 - 1. UL 1283.
 - 2. UL 1449.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports, including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- E. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain surge-protective devices and accessories through one source from a single manufacturer.

- C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of SPDs and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
- G. Comply with the latest editions of UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Surge-Protective Devices."

1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- B. Service Conditions: Rate surge-protective devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, non-condensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

1.5 COORDINATION

- A. Coordinate location of field-mounted surge-protective devices to allow adequate clearances for maintenance.
- B. Coordinate surge-protective devices with Division 26 Section "Electrical Power Monitoring and Control."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge-protective devices which fail in materials or workmanship within five years from date of Substantial Completion.

- B. Special Warranty for Cord-Connected, Plug-in Surge-Protective Devices: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge-protective devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following (**No Substitutions**):
 - 1. Current Technology, Inc.; Thomas & Betts. (CG Plus Series for Type 1, TG Series for Type 2, and CG Series for Type 2b)
 - 2. Cutler-Hammer, Inc.; Eaton Corporation. (SPD Series for Type 1, SPV Series for Type 2, and CVX Series for Type 2b)
 - 3. Liebert Corporation; a division of Emerson. (LM Series for Type 1, Accuvar Series for Type 2, and Accuvar CM Series for Type 2b)

2.2 SERVICE ENTRANCE SPDs (TYPE 1 SPDs)

- A. Surge-Protective Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
 - 1. Fuses, rated at 200-kA interrupting capacity.
 - 2. Fabrication using bolted compression lugs for internal wiring.
 - 3. Integral disconnect switch.
 - 4. Redundant suppression circuits.
 - 5. Redundant replaceable modules.
 - 6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 - 7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 8. LED indicator lights for power and protection status.
 - 9. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 10. One set of dry contacts rated at 5-A and 250-VAC, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 - 11. Surge-event operations counter.
- B. Peak Single-Impulse Surge Current Rating: 240 kA per phase.
- C. Connection Means: Permanently wired, integral or external as indicated on the drawings.
- D. Protection modes and UL 1449 VPR for 3-phase, 4-wire, grounded wye circuits with voltages of 480Y/277, 208Y/120, or 600Y/347 as indicated on the drawings shall be as follows:
 - 1. Line to Neutral: 1200 V for 480Y/277, 800 V for 208Y/120, 1500 V for 600Y/347.

2. Line to Ground: 1200 V for 480Y/277, 900 V for 208Y/120, 1500 V for 600Y/347.
 3. Neutral to Ground: 1000 V for 480Y/277, 700 V for 208Y/120, 1200 V for 600Y/347.
- E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 800 V.
 2. Line to Ground: 900 V.
 3. Neutral to Ground: 700 V.
- F. Protection modes and UL 1449 VPR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 800 V, 1200 V from high leg.
 2. Line to Ground: 900 V.
 3. Neutral to Ground: 700 V.
- G. Protection modes and UL 1449 VPR for 3-phase, 3-wire delta circuits with voltages of 240, 480, or 600 as indicated on the drawings shall be as follows:
1. Line to Line: 2000 V for 480 V, 1200 V for 240 V, 2500 V for 600 V.
 2. Line to Ground: 2000 V for 480 V, 1200 V for 240 V, 2500 V for 600 V.

2.3 PANELBOARD SURGE-PROTECTIVE DEVICES (TYPE 2 SPDs)

- A. Surge-Protective Device Description: Modular design with field-replaceable modules, sign-wave-tracking type with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits.
 5. Redundant replaceable modules.
 6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 7. LED indicator lights for power and protection status.
 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 9. One set of dry contacts rated at 5-A and 250-VAC, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 10. Surge-event operations counter.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per phase.
- C. Protection modes and UL 1449 VPR for 3-phase, 4-wire, grounded wye circuits with voltages of 480Y/277, 208Y/120, or 600Y/347 as indicated on the drawings shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277, 800 V for 208Y/120, 1500 V for 600Y/347.
 2. Line to Ground: 1200 V for 480Y/277, 900 V for 208Y/120, 1500 V for 600Y/347.
 3. Neutral to Ground: 1000 V for 480Y/277, 700 V for 208Y/120, 1200 V for 600Y/347.

- D. Protection modes and UL 1449 VPR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 800 V.
 2. Line to Ground: 900 V.
 3. Neutral to Ground: 700 V.
- E. Protection modes and UL 1449 VPR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 800 V, 1200 V from high leg.
 2. Line to Ground: 900 V.
 3. Neutral to Ground: 700 V.
- F. Protection modes and UL 1449 VPR for 3-phase, 3-wire delta circuits with voltages of 240, 480, or 600 as indicated on the drawings shall be as follows:
1. Line to Line: 2000 V for 480 V, 1200 V for 240 V, 2500 V for 600 V.
 2. Line to Ground: 1800 V for 480 V, 1200 V for 240 V, 2000 V for 600 V.

2.4 SURGE-PROTECTIVE DEVICES FOR ELECTRONIC-GRADE PANELBOARDS (TYPE 2b SPDs)

- A. Surge Protection Device Description: Sine-wave-tracking type, panel-mounted design with the following features and accessories:
1. LED indicator lights for power and protection status.
 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 3. One set of dry contacts rated at 5-A and 250-VAC, for remote monitoring of protection status.
 4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per phase.
- C. Protection modes and UL 1449 VPR for 3-phase, 4-wire, grounded wye circuits with voltages of 480Y/277, 208Y/120, or 600Y/347 as indicated on the drawings shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277, 800 V for 208Y/120, 1200 V for 600Y/347.
 2. Line to Ground: 1200 V for 480Y/277, 800 V for 208Y/120, 1200 V for 600Y/347.
 3. Neutral to Ground: 1200 V for 480Y/277, 700 V for 208Y/120, 1200 V for 600Y/347.
- D. Protection modes and UL 1449 VPR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 800 V.
 2. Line to Ground: 800 V.
 3. Neutral to Ground: 700 V.
- E. Protection modes and UL 1449 VPR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 800 V, 1200 V from high leg.
2. Line to Ground: 800 V.
3. Neutral to Ground: 700 V.

F. Protection modes and UL 1449 VPR for 3-phase, 3-wire delta circuits with voltages of 240, 480, or 600 as indicated on the drawings shall be as follows:

1. Line to Line: 2000 V for 480 V, 1200 V for 240 V, 2500 V for 600 V.
2. Line to Ground: 1800 V for 480 V, 1200 V for 240 V, 2500 V for 600 V.

2.5 PLUG-IN SURGE-PROTECTIVE DEVICES (TYPE 3 SPDs)

A. Description: Non-modular, plug-in surge-protective devices with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:

1. LED indicator lights for power and protection status (Direct plug-in).
2. LED indicator lights for power, protection status, reverse polarity and open outlet ground (Cord connected).
3. Circuit breaker and thermal fusing. When protection is lost, circuit opens.
4. Close-coupled direct plug-in or cord connected with 15-foot line cord as indicated on the drawings.

B. Peak Single-Impulse Surge Current Rating: 33 kA per phase.

C. Protection modes and UL 1449 VPR shall be as follows:

1. Line to Neutral: 475 V.
2. Line to Ground: 475 V.
3. Neutral to Ground: 475 V.

2.6 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE-PROTECTIVE DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multi-pole circuit breaker as a dedicated disconnect for the SPD, unless otherwise indicated. Amperage rating and conductor sizes shall be per the

manufacturer's requirements. Where a conflict exists between the drawings and the manufacturer, the manufacturer's requirements shall supersede the drawings.

3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect service entrance equipment or panelboards to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.
 - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:
- C. Testing: Perform the following field tests and inspections and prepare test reports:
 - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 264313

SECTION 265116 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior fluorescent luminaires, lamps, and ballasts.
2. Luminaire supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260926 "Lighting Control Panelboards" for panelboards used for lighting control.
3. Section 260936.19 "Standalone Multipreset Modular Dimming Controls" for architectural dimming systems.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating
- E. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, arranged by designation.
- B. Shop Drawings: For nonstandard or custom luminaires.
 1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled luminaires, from manufacturer.
- D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 FLUORESCENT LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

- D. UL Compliance: Comply with UL 1598.
- E. Nominal Operating Voltage: See Light Fixture Schedule on plans.
- F. Recessed Luminaires: Comply with NEMA LE 4.

2.3 LED LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. CRI of minimum 80. CCT of 4100 K.
- F. Rated lamp life of 50,000 hours.
- G. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- H. Internal driver.
- I. Nominal Operating Voltage: See Light Fixture Schedule on Plans.
 - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.4 LED EXTERIOR LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.6].
- F. CRI of minimum 80. CCT of 4100 K.
- G. L70 lamp life of 50,000 hours.

- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Nominal Operating Voltage: See Light Fixture Schedule on plans.
- J. In-line Fusing: Separate in-line fuse for each luminaire.
- K. Lamp Rating: Lamp marked for outdoor use.
- L. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.
- N. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- O. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

2.5 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 - 1. Clear, UV-stabilized acrylic.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.6 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish shall match luminaire.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- D. Install lamps in each luminaire.
- E. Supports: Sized and rated for luminaire weight.
- F. Ceiling-Grid-Mounted Luminaire Supports:
 - 1. Install ceiling support system rods or wire for each luminaire. Locate not more than 6 inches from luminaire corners.
 - 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
 - 3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on luminaire. Wire or rod shall have breaking strength of the luminaire weight at a safety factor of 3.
- G. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.

H. Wall-Mounted Luminaire Support:

1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.

I. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

K. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265116

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with integral or remote emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support, arranged by designation.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, coordinated with each other, using input from installers of the items involved:
- B. Product Certificates: For each type of luminaire.

- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
- D. Sample Warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **Two** year(s) from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for recessed luminaires.

- F. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.
1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet.
 4. Test Push-Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- G. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
1. Emergency Connection: Operate one fluorescent or LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Nightlight Connection: Operate lamp in a remote fixture continuously.
 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 5. Charger: Fully automatic, solid-state, constant-current type.

6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the ballast manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Luminaires: See Light Fixture Schedule on plans.

2.4 MATERIALS

- A. Metal Parts:
 1. Free of burrs and sharp corners and edges.
 2. Sheet metal components shall be steel unless otherwise indicated.
 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 1. Smooth operating, free of light leakage under operating conditions.
 2. Designed to permit relamping without use of tools.
 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 1. Glass: Annealed crystal glass unless otherwise indicated.
 2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.5 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of fixture weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached using through bolts and backing plates on either side of wall.
 - 2. Do not attach fixtures directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of fixture oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
- H. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265219

DIVISION 27
COMMUNICATIONS

SECTION 270000 - BASIC TELECOMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 APPLICABLE CODES AND STANDARDS

- A. All work shall conform to the standards and codes of the following organizations and publications as applicable.
- B. When a conflict occurs, follow the most stringent requirements.
- C. Codes and Standards:
 - 1. NFPA - National Fire Code
 - 2. NEC - National Electrical Code
 - 3. ANSI - American National Standards Institute
 - 4. ANSI/NECA/BICSI 568-2001
 - 5. TIA - Telecommunications Industry Association
 - 6. TIA-568-C - Commercial Building Standards for Telecommunications
 - 7. TIA-569-D - Commercial Building Standards for Pathways and Spaces
 - 8. TIA-606-B - Administration
 - 9. BICSI OSP - Outside Plant Design Manual
 - 10. BICSI TDMM - Telecommunications Distribution Methods Manual 14th Edition
 - 11. EIA - Electronic Industries Association
 - 12. FCC - Federal Communications Commission
 - 13. ICBO - International Conference of ICBO Building Officials
 - 14. IEEE - Institute of Electrical and Electronic Engineer
 - 15. IBC - International Building Code
 - 16. All local codes and regulations

1.2 ABBREVIATIONS

- A. Abbreviations: The following abbreviations or initials may be used:
 - 1. ABV CLG - Above Ceiling
 - 2. AC - Alternating Current
 - 3. ADA - American Disabilities Act
 - 4. AFF - Above Finished Floor
 - 5. AFG - Above Finished Grade
 - 6. AMP - Ampere
 - 7. AWG - American Wire Gauge
 - 8. BC - Bare Copper
 - 9. CCTV - Closed Circuit Television
 - 10. CATV - Community antenna television
 - 11. CLG - Ceiling
 - 12. COAX - Coaxial Cable
 - 13. CPU - Central Processing Unit
 - 14. DC - Direct Current
 - 15. DEG - Degree

16. EMT - Electrical Metallic Tubing
17. GND - Ground
18. IDF - Intermediate Distribution Frame (Telecom Room)
19. IMC - Intermediate Metallic Conduit
20. IN - Inches
21. IP - Internet Protocol
22. JB - Junction Box
23. KVA - Kilo-Volt-Amps
24. KW - Kilowatts
25. LBS - Pounds
26. LED - Light Emitting Diode
27. MAX - Maximum
28. MDF - Main Distribution Frame (Main Telecom Room)
29. MIC - Microphone
30. MIN - Minimum
31. MTD - Mounted
32. MTG - Mounting
33. NECA - National Electrical Contractors Association
34. NEMA - National Electrical Manufacturers Association
35. NIC - Not in Contract
36. OFE - Owner furnished equipment
37. OSHA - Occupational Safety and Health Administration
38. PB - Push button
39. PWR - Power
40. PVC - Polyvinylchloride
41. SCS - Structured Cabling System
42. EF - Telecommunications Entrance Facility
43. TR - Telecommunications Room
44. TTB - Telephone Terminal Board
45. UON – Unless Otherwise Noted
46. V - Volt
47. WAP - Wireless Access Point
48. WP - Weatherproof

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Quality assurance:

1. Installers Qualifications: Contractor with a minimum of five years documented successful installation experience on projects utilizing cabling infrastructure work similar to that required for this project. The contractor shall be an experienced firm regularly engaged in the layout and the installation of cabling infrastructure systems. The contractor must be able to show evidence that he has successfully completed projects of similar size and scope in the last 12 months. The contractor shall be a manufacturer certified Business Partner, CVA, or for the TE solution the installers, supervisors, registered certifier, and designers to have a current valid certification card.
 - a. The Network Communications project manager must have experience in this type of project, and he/she expected to provide technical support.
 - b. The Network Communications project manager shall attend the monthly progress meetings held by the state and additional meetings as scheduled or required.
 - c. BICSI registration must be current and the installer and technicians must be in good standing.
 - d. During the shop drawing process, provide copies of all manufacturer and BICSI certifications, the contractor shall meet the following criteria: 15% of work force shall be BICSI certified 'Technician level or better (RCDD). 15% of work force shall be BICSI certified Installer level 2 or higher; 15% of work force shall be BICSI certified installer level 1 or of equivalent experience/training.
 - e. Contractor employees will wear visible ID badges on the job site with current picture and company name at all times.

B. Application Assurance:

1. Covers failure of the channel SCS to operate the applications, that the Solution is to support, as well as additional application(s) included in the numbered list. Manufacturer warrants that the registered channel SCS solution will be free from failures which prevent operation of the specific applications for which the original channel SCS was designed.

C. The Application Assurance Program also covers the following additional applications:

1. Those identified in the current (at the time of installation) channel SCS Performance Specifications
2. In accordance with application standards specifications, any applications introduced in the future by recognized standards or user forums that use TIA/EIA 568 or ISO/IEC 11801 components and link/channel specifications for cabling.
3. The contractor's certifications are current for the manufacturer's solution installation. The contractor shall provide standards compliant, warranted, end-to-end channel solution for structured cabling solutions.

1.6 WARRANTY

A. Manufacturer Warranty

1. Contractor shall provide a minimum Twenty (20) year cabling Extended Product Warranty and Application Assurance.
2. The warranty will support any performance claims the manufacturer makes over and above the Category 6 standards stated herein.

3. A Warranty statement from the Manufacturer stating the period of the warranty for all the products specified for the project and the name and address of the authorized manufacturers agent who will honor the warranty claims.

B. Extended Product Warranty

1. The Extended Product Warranty will cover product defects for all passive manufactured channel components. Passive components are those exhibiting no gain or contributing no energy.
2. Manufacturer warrants, from the date a Registration Certificate passes to the end-user, the following:
 - a. That the passive products that comprise the registered Channel solution will be free from manufacturing defects in material or workmanship under normal and proper use.
 - b. That all channel approved passive cabling products that comprise the registered channel solution exceed the specification of TIA 568 and exceed ISO/IEC 11801 standards and will be equal to or exceed to the performance specifications of the associated Communication product data sheet in effect at the time the Registration Certificate is issued.
 - c. That the installation will exceed the insertion and return loss, attenuation and near end cross talk (NEXT) requirements of TIA 568-B and the ISO/IEC 11801 standards for cabling links/channel configurations specified in these standards.
 - d. That each channel is comprised exclusively of a single manufacturer solution and is capable of delivering 1.2 Gbps (Cat 5e), 3.6 Gbps (Cat 6) or 10 Gbps (Cat 6A) to the workstations or WAPs in accordance with applications standards.
 - e. This extended Product Warranty is applicable to the channel cabling solution products only on the original site of installation. Under the Extended Product Warranty, Manufacturer will either repair or replace the defective product itself at Manufacturers' cost. The U.S.A., Manufacturer will pay an Authorized cable installation Reseller for the cost of labor to repair or replace any such defective product on behalf of Manufacturer.
 - f. Corning Cable Systems LANscape solutions "landscape extended warranty" a 25-year guarantee on complete fiber optic cabling solutions. The telecom contractor shall be an authorized Corning Cabling Systems extended warranty (NPI) installer.

C. Additional Warranty

1. Contractor shall state any additional Contractor supplied warranty. This contractor warrants the Network communications cabling infrastructure system to be free of defects in the materials and workmanship for the period of one year after the date of final payment. The effective date of this warranty applies to all components of these systems regardless of any equipment manufacturer's warranties, which may expire at an earlier date. Any system malfunctions or any previously undiscovered non-compliance with the plans and specifications during the warranty period are repaired at no cost to the Owner are brought into compliance.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with latest TIA-607 standard.

2.2 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

2.3 GROUNDING & BONDING

- A. Comply with requirements for identification products in Section 270526 "Grounding and Bonding for Communications Systems."

2.4 CABLE TRAYS & PATHWAYS

- A. Comply with requirements for identification products in Section 270536 "Identification for Communications Systems."
- B. Maintain fire ratings at all floor and wall penetrations by providing UL listed, fire-rated, telecommunications pathway devices.
- C. Provide UL listed, fire-rated, devices at all locations required by NFPA regulatory codes.
 - 1. Devices must be tested in accordance with ASTM E 814 (ANSI/UL1479).
- D. Conduits:
 - 1. All interior telecommunications conduits shall be, at minimum, 1-1/4" EMT conduits unless otherwise noted in project documents.
 - 2. Achieve the best direct route (e.g., usually parallel to building lines)
 - 3. No bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
 - 4. Contain no continuous sections longer than 30.5 m (100 ft.).
 - 5. Conduit bonding is to ground on one or both ends in accordance with national or local requirements.
 - 6. Conduit type selection is to withstand the environment and meet code for installation.
 - 7. For runs that total more than 30.5 m (100 ft.) in length, pull points or pull boxes installed so that no segment between points/boxes exceeds the 30.5 m (100 ft.) limit. Total conduit runs kept to 45.8 m (150 ft.) or less (including the sections through pull boxes).
 - 8. Install nylon pullstring with >200 lbs tensile strength in all installed conduits.

2.5 COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

- A. Comply with requirements for identification products in Section 271116 "Communications Racks, Frames, and Enclosures."

2.6 COMMUNICATIONS COPPER BACKBONE CABLING

- A. Comply with requirements for identification products in Section 271313 "Communications Copper Backbone Cabling."

2.7 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

- A. Comply with requirements for identification products in Section 271323 "Communications Optical Fiber Backbone Cabling."

2.8 COMMUNICATIONS COAXIAL BACKBONE CABLING

- A. Comply with requirements for identification products in Section 271333 "Communications Coaxial Backbone Cabling."

2.9 COMMUNICATIONS COPPER HORIZONTAL CABLING

- A. Comply with requirements for identification products in Section 271513 "Communications Copper Horizontal Cabling."

2.10 COMMUNICATIONS COAXIAL HORIZONTAL CABLING

- A. Comply with requirements for identification products in Section 271533 "Communications Coaxial Horizontal Cabling."

PART 3 - EXECUTION

3.1 INSTALLATION

3.2 APPLICATION

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. All testing equipment must be using the latest manufacturer firmware.
 - 2. All testing equipment must have been calibrated within the last year.
 - 3. All testing equipment must meet or exceed the owner's minimum testing requirements.

4. All testing must meet manufacturer's warranty requirements.

B. Tests and Inspections:

1. Visually inspect all components for defects prior to installation. Defective materials to be replaced at no cost to owner.
2. Verify workmanship of installed components meets owner's requirements and standards. Owner and/or owners' representative to give final approval of installed systems prior to turnover to owner.
3. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
4. 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.
5. 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 Engineer promptly and include recommendations to reduce ground resistance.

D. Copper category 5e and/or 6 channels shall be tested as appropriate, with only PASSing values accepted, using a TIA-568-compliant Cat 6 Time-Domain Reflectometer. Copper category 6A channels shall be tested, with only PASSing values accepted, using a TIA-568-compliant Augmented Cat 6 (Cat 6A) Time-Domain Reflectometer.

E. Horizontal Cable Testing

1. Channel testing: Each equipment Network communications room patch cord, patch panel, horizontal cable, RJ 45 jack, Station patch cord will be tested end- to- end for compliance with category 6 level III parameters as stated in the TIA- 568 family of standards. Only certified cat 6-cable testing allowed on each all beyond cat 6 cables. The Test equipment used for horizontal category six cable tests complies with the industry standard Category 6 cable testers level III and comply with TIA test procedures. Each link shall be tested to TIA-568-C pinout, with only PASS results accepted. The contractor, at no charge to the owner, shall bring any pairs not meeting the requirements of the standard into compliance

and complete end-to-end test results documentation to the owner. The test results will require 2-cd copies.

F. Fiber Optic Testing

1. Each 62.5 OR 50/125-micron fiber will be tested patch panel to patch panel at the 850 and 1300 nm wavelength in both directions using a light meter. Each single mode fiber will be tested patch panel to patch panel at the 1310 and 1550 nm wavelength both directions using a light meter. The maximum total attenuation for any single fiber between patch panels will not exceed 2.0 db.
2. Power meter tests: For building risers, power meter tests are required.
3. Provide a power test and OTDR test for length, attenuation, and micro bends for each individual fiber. Documentation will include the power test and OTDR results.
4. Test results included for inclusion into the documentation package.
5. Link attenuation does not include any active devices or passive devices other than cable connectors and splices.
6. A final report shall be compiled that records system configuration, fiber labels, cable routes, and as-builts details and as-built drawings.

G. Computer Generated Report

1. All cables/connectors shall be tested provide test equipment generated print out for each cable/connector, indicating that the channel end-to-end solution has passed or failed.
2. Test results:
 - a. Provide two cd copies.

END OF SECTION 270000

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding labeling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
1. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 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 RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with latest TIA-607 standard.

2.2 CONDUCTORS

- A. Manufacturers:
 - 1. Panduit Corporation
 - 2. The Siemon Company
 - 3. Harger Lightning & Grounding.
 - 4. Tyco Electronics Corp.
 - 5. Burndy; Part of Hubbell Electrical Systems
- B. Comply with UL 486A-486B.
- C. 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.
- 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: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 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. Manufacturers:
 - 1. Panduit Corporation
 - 2. The Siemon Company
 - 3. Harger Lightning & Grounding.
 - 4. Tyco Electronics Corp.

5. Burndy; Part of Hubbell Electrical Systems

- B. 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.
- C. 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.
- D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes 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. Manufacturers:
 - 1. Panduit Corporation
 - 2. The Siemon Company
 - 3. Harger Lightning & Grounding.
 - 4. Tyco Electronics Corp.
 - 5. Burndy; Part of Hubbell Electrical Systems
 - 6. Eaton B-Line
- B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with latest TIA-607 standard.
 - 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.
- C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with latest TIA-607 standard.
 - 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.
- D. 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 latest TIA-607 standard. 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.

2.5 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

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 latest TIA-607 standard.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 1. The bonding conductors between the 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 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 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. 3/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 60 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. Daisy chaining of connections is not permitted. Individual bonding conductors must be utilized for components needing to be connected to the TGB or TMGB.

- D. Provide and use self-scoring installation hardware on devices that have painted surfaces. Prior to installation, remove paint from bonding surface and secure bonding connector using self-scoring hardware.
- E. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- F. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- G. 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 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- H. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- I. 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.
- J. 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.
- K. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- L. 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.
- M. Access Floors: Bond all metal parts of access floors to the TGB.
- N. Cable Tray: Bond all segments of cable tray to the adjacent segments of cable tray using bonding jumper. Bond all corners using bonding jumper. At a location near the TGB, bond the tray system to the TGB using a No. 2 AWG bonding conductor.
- O. Sleeve systems: Bond all sleeve systems entering the telecommunications spaces to the local TGB using a No. 2 AWG bonding conductor.

3.7 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!"

3.8 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 Engineer 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 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Surface pathways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. Retain "ARC" Paragraph below for corrosion resistance and other special conditions.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression
 - 2. 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.
- F. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Continuous HDPE: Comply with UL 651B.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum or general-use installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-B.
 - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: Fully adjustable.
 - 3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
 - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- J. Gangable boxes are prohibited.
- K. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic or fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.5

A. Cabinets:

1. NEMA 250, Type 1 or Type 3R, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as applicable.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT
2. Exposed, Not Subject to Severe Physical Damage: EMT.

3. Exposed and Subject to Severe Physical Damage: GRC.
 4. Damp or Wet Locations: GRC.
 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway.
 7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway.
 8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 nonmetallic in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: ½ inch trade size. Minimum size for optical-fiber cables is 1 inch.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.1.
- E. Install surface pathways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 135 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of 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.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. 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.
 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- H. Stub-ups to Above Recessed Ceilings:
1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- J. 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.
- K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- L. 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.
- M. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.
- N. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
- O. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.
- P. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.
- Q. 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.
- R. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- S. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. 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 rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60

inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- C. Install handholes with bottom below frost line below grade.
- D. Field cut openings for conduits according to enclosure manufacturer's written instructions.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.

END OF SECTION 270528

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Runway ladder cable tray.
2. Wire mesh cable tray.
3. Cable tray accessories.
4. Warning signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 (Minimum 12") 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.

1.3 INFORMATIONAL SUBMITTALS

A. 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. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

- C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.2 RUNWAY LADDER CABLE TRAY

A. Manufacturers:

1. Legrand: 09-8104 Series
2. Eaton B-Line
3. Snake Tray: 610 Series
4. MonoSystems
5. Middle Atlantic: CLB Series

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Minimum Width: 12 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 1 inch.
4. Straight Section Lengths: 10 feet except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 9 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. 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.
10. Fitting Minimum Radius: 12 inches.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel

2.3 WIRE MESH CABLE TRAY

A. Manufacturers:

1. Legrand: Cablofil Series
2. Eaton B-Line: Flex Tray Series
3. Snake Tray: Mega-Snake Series
4. MonoSystems: Mono-Mesh
5. Siemon: RouteIT Series

B. Description:

1. Configuration: steel wire mesh, complying with NEMA VE 1.
2. Minimum Width: 12 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches
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:

1. Steel

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. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."
- B. 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."

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. Fasten cable tray supports to building structure.
- D. 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."
- E. Support wire-basket cable trays with trapeze hangers
- F. Support trapeze hangers for wire-basket trays with 3/8-inch- diameter rods.
- G. 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.
- H. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- I. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- J. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- L. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- M. 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 with shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. 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 straps. Nylon cable tie wraps are not acceptable. Bundle sizes shall not exceed 24 cables each.
- 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. Connect raceways 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 electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by 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 retorquer in suspect areas.
 - 7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 8. 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.

END OF SECTION 270536

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Signs.
6. Cable ties.
7. Fasteners for labels and signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Identification Schedule:

1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and latest TIA 606 standard.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 SIGNS

A. Laminated-Acrylic or Melamine-Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face]
 - d. Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 CABLE TIES

A. Manufacturers:

1. Panduit
2. Velcro
3. Rip-Tie

B. Plenum-Rated Hook and Loop Cable Ties:

1. Minimum Width: 1/2 inch.
2. Minimum Tensile Strength: 40 lbs.
3. Flammability Rating: UL94 V-2
4. Temperature Range: 0°F to 122°F
5. Color: Black.
6. Utilize in Spaces Handling Environmental Air

C. Hook and Loop Cable Ties:

1. Minimum Width: 3/4 inch.
2. Minimum Tensile Strength: 50 lbs.
3. Temperature Range: 0°F to 220°F
4. Color: Black.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- ### A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Verify identity of each item before installing identification products.
- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Apply identification devices to surfaces that require finish after completing finish work.
- E. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

- F. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- G. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label within 6 inches from cable end.
- H. Snap-Around Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label within 6 inches from cable end.
- I. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label within 6 inches from cable end.
- J. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

3.2 IDENTIFICATION SCHEDULE

- A. Administration Class: Class 4. Include optional identification requirements of this standard. Administration Class applies project wide.
- B. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- C. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 - 1. System legends shall be as follows:
 - a. Telecommunications.
- E. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress composed of the following, in the order listed:

1. Wiring closet designation.
 2. Colon.
 3. Faceplate number.
- F. Equipment Room Labeling:
1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels.
 2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.
 - c. Faceplate number.
- G. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- H. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
1. Room number.
 2. Colon.
 3. Faceplate number.
- I. Instructional Signs: Self-adhesive labels.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels
1. Apply to exterior of door, cover, or other access.
- K. Equipment Identification Labels:
1. Indoor Equipment: Self-adhesive label
 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
 3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.
 - c. Computer room air conditioners.
 - d. Fire-alarm and suppression equipment.
 - e. Egress points.
 - f. Power distribution components.

END OF SECTION 270553

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. 19-inch equipment cabinets.
 - 2. Power strips.

1.2 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications racks, frames, and enclosures. 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. Detailed Rack Elevations indicating layout of equipment. Coordinate with ITS department.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Data: Certificates, from manufacturer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when work of this section is performed at project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL listed.
- B. RoHS compliant.

2.2 19-INCH EQUIPMENT CABINETS

- A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting.
- B. Manufacturers:
 1. Panduit
 2. Chatsworth
 3. Great Lakes
 4. Siemon
 5. Middle Atlantic
 6. Ortronics
- C. General Cabinet Requirements:
 1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 2. Material: Aluminum.
 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 4. Color: Black.
- D. Modular Wall Cabinets:
 1. Height: As indicated on Drawings.
 2. Depth: 29 inches.
 3. Load Rating: 150 lb
 4. Number of Rack Units: As indicated on Drawings.
 5. Threads: 12-24.
 6. Lockable front doors.
 7. Louvered side panels.
 8. Cable access provisions top and bottom.
 9. Grounding lug.

10. Power strip.
11. All cabinets keyed alike.

E. Cable Management:

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 top of each relay rack, with a minimum height of two rack units each.

2.3 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, with flanges.
3. Height: 1 RU.
4. Housing: Metal.
5. (12) 120-VAC, 5-15R Receptacles.
6. (2) Front and (10) Rear Receptacles.
7. LED indicator lights for power and protection status.
8. LED indicator lights for reverse polarity and open outlet ground.
9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
10. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
11. Cord connected with 12-foot line cord.
12. Rocker-type on-off switch
13. Surge Protection: UL 1449, Type 3.
 - a. Maximum Surge Current, Line to Neutral: 72 kA.
 - b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
 - c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V and 500 V for neutral to ground.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations 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 equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

END OF SECTION 271116

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
3. Cabling identification products.

1.2 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.

1.3 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 to show typical wiring schematics including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
5. Cross-connects and patch panels.

C. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Field quality-control reports.
- C. Product Certificates: For each type of product.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of shop drawings, cabling administration drawings, and field-testing program development by an RCDD.
 - 2. Installation: Installer shall be manufacturer certified to install cabling system submitted.
 - 3. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when work of this section is performed at project site.
 - 4. Testing Supervisor: Currently certified by BICSI as a RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.7 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. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. 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.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4)

A. Description: Multimode, 50/125-micrometer, conductive/armored tight buffer, optical fiber cable.

B. Manufacturers:

1. Panduit
2. Leviton
3. Corning
4. Berk-Tek
5. OCC

C. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAD for detailed specifications.

D. Conductive cable shall be aluminum armored type.

E. Maximum Attenuation: 3.0 dB/km at 850 nm; 1.0 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.

H. 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.

I. 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.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers:

1. Panduit
2. Leviton
3. Corning

4. Berk-Tek
5. OCC

B. Standards:

1. Comply with Optical Fiber Connector Intermateability Standard specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. 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.

D. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

E. Connector Type: Type LC complying with TIA-604-10-B

F. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

2.4 IDENTIFICATION PRODUCTS

- A. Comply with latest TIA-606 standard and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test 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 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal all raceway, except where not possible in unfinished mechanical/electrical spaces.
- B. 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.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
 - 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 minimum 10-foot-long service loop unless otherwise noted.
 - 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. Group connecting hardware for cables into separate logical fields.

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 ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with latest TIA-607 standard and NECA/BICSI-607.
- 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.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B.
- C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.
- 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, 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. Label each unit and field within distribution racks and frames.
 - 4. 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. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- 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.

END OF SECTION 271323

SECTION 271333 - CATV COAXIAL BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. CATV coaxial cable.
2. Coaxial cable hardware.
3. Identification products.

1.2 COAXIAL BACKBONE CABLING DESCRIPTION

- A. Coaxial 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.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Nominal OD.
2. Minimum bending radius.
3. Maximum pulling tension.

B. Shop Drawings:

1. System Floor plans indicating cable category, cable color and jack color at each location for designer/owner approval prior to purchasing materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Field quality-control reports.
- C. Maintenance data.

1.5 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of shop drawings, cabling administration drawings, and field-testing program development by an RCDD.
2. Installation: Installer shall be manufacturer certified to install cabling system submitted.
3. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when work of this section is performed at project site.
4. Testing Supervisor: Currently certified by BICSI as a RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- ### A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

2.2 GENERAL CABLE CHARACTERISTICS

- ### A. CATV Cable: 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. CATV Plenum Rated: Type CATVP complying with NFPA 262.

2.3 CATV COAXIAL CABLE

- ### A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.

- ### B. NFPA and UL compliant, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution" Article. Types are as follows:

1. RG-11: UL Type CATVP.

- a. No. 18 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
- b. Plenum rated.
- c. Gas-injected, foam-PE insulation.
- d. Shielded with 100 percent aluminum tape and 60 percent aluminum braid.
- e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
- f. Jacketed with black PVC or PE.
- g. Suitable for indoor installations.

2.4 COAXIAL CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.
- B. Coaxial-Cable Connectors: Type BNC, 75 ohms.
- C. Patch Cords: Factory-made cables in 48-inch lengths; terminated with modular Type BNC connector at each end.
- D. Faceplates:
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.
- E. Legend:
 - 1. Factory labeled by silk-screening or engraving for stainless steel faceplates.
 - 2. Machine printed, in the field, using self-adhesive labels.
 - 3. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 IDENTIFICATION PRODUCTS

- 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. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal all raceway, except where not possible in unfinished mechanical/electrical spaces.
- B. 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.

3.3 INSTALLATION OF PATHWAYS

- A. Comply with requirements specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for installation of conduits and wireways.
- C. Comply with Section 270528.29 "Hangers and Supports for Communications Systems."
- D. Drawings indicate general arrangement of pathways and fittings.
- E. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

3.4 INSTALLATION OF COAXIAL BACKBONE CABLES

- A. Comply with NECA 1, TIA 568-C.4, and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
 - 3. 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.
 - 4. 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.
 - 5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 7. In the communications equipment room, install a minimum 10-foot-long service loop unless otherwise noted.

8. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend coaxial cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 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.

3.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with latest TIA-607 standard.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. 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. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips and identified each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 4. 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.

- D. 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.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections
- B. Tests and Inspections:
 - 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 2. Test coaxial backbone copper 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.
- C. 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.
- 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 271333

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6A 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.
1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 3. 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:
1. Floor plans indicating cable category, cable color and jack color at each location for designer/owner approval prior to purchasing materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

- B. Product Certificates: For each type of product.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. As-builts with cabling administration information

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of shop drawings, cabling administration drawings, and field-testing program development by an RCDD.
 - 2. Installation: Installer shall be manufacturer certified to install cabling system submitted.
 - 3. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when work of this section is performed at project site.
 - 4. Testing Supervisor: Currently certified by BICSI as a RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as a RCDD.

1.7 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. 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.

2.2 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

2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- 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.
- C. RoHS compliant.

2.3 CATEGORY 6A TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500MHz.
- B. Manufacturers:
 1. General Cable: GenSPEED 10
 2. Panduit
 3. Siemon
 4. Berk-Tek
- C. Standard: Comply with TIA-568-C.2 for Category 6A cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP)
- F. Cable Rating: Plenum.
- G. Jacket: Refer to drawings for system specific color coding.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers:
 1. Panduit: Net Key
 2. Siemon
 3. Berk-Tek
 4. Leviton
- C. General Requirements for Twisted Pair Cable Hardware:
 1. Comply with the performance requirements of associated cabling.
 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.
- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- E. Connecting Blocks:
 1. 110-style IDC for Category 6.
 2. 110-style IDC for Category 6A.
 3. Provide blocks for the number of cables terminated on the block, plus 25% spare, integral with connector bodies, including plugs and jacks where indicated.
- F. 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.
- G. Patch Panel: Modular 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. Replaceable connectors.
 - d. 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
- H. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; 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.
- I. 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.
- J. 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.

- K. Faceplate:
1. Shall match adjacent receptacle material and finish. Coordinate with Architect.
 2. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
- L. Legend:
1. Machine printed, in the field, using adhesive-tape label.
 2. Snap-in, clear-label covers and machine-printed paper inserts.

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. Conceal all raceway, except where not possible in unfinished mechanical/electrical spaces.
- 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's Information Transport Systems Installation Methods Manual, 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 information Transport Systems Installation Methods Manual, 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 minimum 10-foot-long service loop unless otherwise noted.
 12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, 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.
- 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. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
 - B. Comply with latest TIA-607 standard and NECA/BICSI-607.
- 3.4 IDENTIFICATION
- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - B. Paint and label colors for equipment identification shall comply with TIA-606-B.
 - 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. 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.
- 4. 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 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.

3.6 WARRANTY

- A. Cable Manufacturer shall warranty cabling and cabling hardware for a 20-year period.

END OF SECTION 271513

SECTION 271533 - CATV COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. CATV coaxial cable.
2. Coaxial cable hardware.
3. Identification products.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. System Floor plans indicating cable category, cable color and jack color at each location for designer/owner approval prior to purchasing materials.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Field quality-control reports.

C. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.4 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation.

B. Maintenance Data: For coaxial cable, splices, and connectors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of shop drawings, cabling administration drawings, and field-testing program development by an RCDD.
2. Installation: Installer shall be manufacturer certified to install cabling system submitted.
3. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when work of this section is performed at project site.

4. Testing Supervisor: Currently certified by BICSI as a RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

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 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, and the requirements of TIA-568-C.4.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Communications Cable: 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
 2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. CATV Cable: 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. CATV Plenum Rated: Type CATVP complying with NFPA 262.

2.3 CATV COAXIAL CABLE

- A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.
- B. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:
 1. RG-6/U: UL Type CATVP.
 - a. No. 18 AWG, solid, copper-covered steel conductor.
 - b. Plenum rated.

- c. Gas-injected, foam-PE insulation.
- d. Shielded with 100 percent aluminum tape and 60 percent aluminum braid.
- e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
- f. Jacketed with black PVC or PE.
- g. Suitable for indoor installations.

2.4 COAXIAL CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.
- B. Coaxial-Cable Connectors: Type BNC, 75 ohms.
- C. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.
- D. Patch Cords: Factory-made cables in 48-inch lengths; terminated with a male Type BNC connector at each end.
- E. Faceplates:
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 2. Metal Faceplate: Stainless Steel, complying with requirements in Section 262726 "Wiring Devices."
 - 3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.
 - a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.
 - 4. Legend:
 - a. Factory labeled by silk-screening or engraving for stainless steel faceplates.
 - b. Machine printed, in the field, using adhesive-tape label.
 - c. Snap-in, clear-label covers and machine-printed paper inserts.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate horizontal cabling with the protectors and demarcation point provided by communications service provider.

3.2 INSTALLATION OF COAXIAL 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. Conceal all raceway, except where not possible in unfinished mechanical/electrical spaces.
- 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.
- D. General Requirements for Cabling:
1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
 3. 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.
 4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 8. In the communications equipment room, install a minimum 10-foot-long service loop unless otherwise noted.
 9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.
- E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend coaxial cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.
- G. Group connecting hardware for cables into separate logical fields.
- H. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-C, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with latest TIA-607 standard and NECA/BICSI-607.

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."

- B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and 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 device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. 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 being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 4. 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 communications cabling, use a different color for jacks and plugs of each service.
- E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections
- B. Tests and Inspections:
 - 1. Visually inspect coaxial jacket materials for NRTL certification markings.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test coaxial horizontal copper 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.

- C. 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.
- 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 271533

DIVISION 28
ELECTRONIC SAFETY AND SECURITY

SECTION 281500 - ACCESS CONTROL HARDWARE DEVICES

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. Card readers, credential cards, and keypads
 - 2. Biometric identity-verification equipment
 - 3. Cables
 - 4. Transformers

- B. Related Requirements:

- 1. Section 281300 "Access Control System Software and Database Management" for control and monitoring applications, workstations, and interfaces.

1.3 ACTION SUBMITTALS

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

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.

- C. Product Schedules.

- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
 - 2. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - 1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

PART 2 - PRODUCTS

2.1 OPERATION

- A. Security access system hardware shall use a single database for access-control and credential-creation functions.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, "National Electrical Code."

2.3 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

- A. HID

B. Card Readers:

1. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
2. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
3. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
 - a. Indoors, controlled environment.
 - b. Indoors, uncontrolled environment.
 - c. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.
4. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
5. Touch-Plate and Proximity Readers:
 - a. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction and shall receive and decode a unique identification code number transmitted from the credential card.
 - b. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
 - c. The card reader shall read proximity cards in a range from direct contact to at least 6 inches from the reader.

C. Credential Cards:

1. Modification: Entry-control cards shall be able to be modified by lamination direct print process during the enrollment process without reduction of readability. The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the badge holder used at the site.
2. Card Size and Dimensional Stability: Credential cards shall be 2-1/8 by 3-3/8 inches. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.
3. Card Material: Abrasion resistant, nonflammable, nontoxic, and impervious to solar radiation and effects of ultraviolet light.
4. Card Construction:
 - a. Core and laminate or monolithic construction.
 - b. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.
 - c. Furnish equipment for on-site assembly and lamination of credential cards.

2.4 CABLES

- A. General Cable Requirements: Comply with requirements in Section 26519 "Low-Voltage Electrical Power Conductors and Cables" and as recommended by system manufacturer for integration requirement.
- B. Plenum-Rated TIA 232-F Cables:
 - 1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PE insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with NFPA 262.
- C. Plenum-Rated TIA 485-A Cables:
 - 1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Fluorinated ethylene propylene insulation.
 - 3. Unshielded.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. NFPA 70 Type: Type CMP
 - 6. Flame Resistance: NFPA 262, Flame Test.
- D. Multiconductor, PVC, Reader and Wiegand Keypad Cables:
 - 1. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
 - 2. NFPA 70, Type CMG.
 - 3. Flame Resistance: UL 1581 vertical tray.
 - 4. For TIA 232-F applications.
- E. Paired, PVC, Reader and Wiegand Keypad Cables:
 - 1. Three pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
 - 2. NFPA 70, Type CM.
 - 3. Flame Resistance: UL 1581 vertical tray.
- F. Paired, PVC, Reader and Wiegand Keypad Cables:
 - 1. Three pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
 - 2. NFPA 70, Type CM.

3. Flame Resistance: UL 1581 vertical tray.

G. Paired, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum-foil/polypropylene-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

H. Multiconductor, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

I. LAN Cabling:

1. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.5 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.2 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Install cables and wiring according to requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5e rating of components and optical fiber rating of components, and that ensure Category 6 and optical fiber performance of completed and linked signal paths, end to end.
- F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.3 CABLE APPLICATION

- A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. between terminations.
- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.
- E. Card Readers and Keypads:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.

- 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft between terminations.
- G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. between terminations.

3.4 GROUNDING

- A. Comply with Section 270526 "Grounding and Bonding for Communications Systems."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.5 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.

3.6 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.
 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
 3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
1. Complete installation and startup check according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

END OF SECTION 281500

SECTION 283111 – DIGITAL ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Magnetic door holders.
8. Remote annunciator.
9. Addressable interface device.
10. Digital alarm communicator transmitter.

B. Related Requirements:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.
 - c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
- C. Field quality-control reports.
- D. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment.
 - d. Riser diagram.
 - e. Record copy of site-specific software.
 - f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - g. Manufacturer's required maintenance related to system warranty requirements.
 - h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).
- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
- E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Carbon monoxide detectors.
 - 6. Automatic sprinkler system water flow.
 - 7. Fire-extinguishing system operation.
 - 8. Fire standpipe system.
 - 9. Dry system pressure flow switch.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances.
 - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Unlock electric door locks in designated egress paths.
 - 5. Release fire and smoke doors held open by magnetic door holders.

6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate preaction system.
9. Recall elevators to primary or alternate recall floors.
10. Activate elevator power shunt trip.
11. Activate emergency lighting control.
12. Activate emergency shutoffs for gas and fuel supplies.
13. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Elevator shunt-trip supervision.
4. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Fire-Lite Alarms, Inc.; a Honeywell International company.
 2. Gamewell - FCI by Honeywell.
 3. Notifier.
 4. Silent Knight.
 5. SimplexGrinnell LP.
- B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class B.
 2. Pathway Survivability: Level 0.
- E. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
 3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- F. Elevator Recall:
1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.

- c. Smoke detectors in elevator hoistway.
- 2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
- 3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
- G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.
- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.
- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 MANUAL FIRE-ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Faraday.
 - 2. Fire-Lite Alarms, Inc.; a Honeywell International company.
 - 3. Gamewell - FCI by Honeywell.
 - 4. Notifier.
 - 5. Siemens Industry, Inc.; Fire Safety Division.
 - 6. Silent Knight.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.
 - 1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - 2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

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

1. Faraday.
2. Fire-Lite Alarms, Inc.; a Honeywell International company.
3. Gamewell - FCI by Honeywell.
4. Notifier.
5. Siemens Industry, Inc.; Fire Safety Division.
6. Silent Knight.
7. SimplexGrinnell LP.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal
2. In first subparagraph below, retain first option for additions to existing four-wire systems or if detector auxiliary contacts are used for critical control functions such as air-handler shutdowns. Otherwise, retain type based on class of initiating-device circuit. Four-wire detectors have power supply wiring separate from the initiating-device circuit wiring. Both power supply wiring and initiating-device circuit wiring must be supervised.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Multiple levels of detection sensitivity for each sensor.
 - d. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

- a. Primary status.
- b. Device type.
- c. Present average value.
- d. Present sensitivity selected.
- e. Sensor range (normal, dirty, etc.).

D. Ionization Smoke Detector:

- 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
- 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

- 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
- 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
- 4. Each sensor shall have multiple levels of detection sensitivity.
- 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

- 1. Mounting: Adapter plate for outlet box mounting.
- 2. Testable by introducing test carbon monoxide into the sensing cell.
- 3. Detector shall provide alarm contacts and trouble contacts.
- 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
- 5. Comply with UL 2075.

6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.8 NONSYSTEM SMOKE DETECTORS

A. General Requirements for Nonsystem Smoke Detectors:

1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

B. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac.
2. Auxiliary Relays: One Form C, rated at 0.5 A.
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
4. Visible Notification Appliance: 177-cd strobe.
5. Heat sensor, 135 deg F combination rate-of-rise and fixed temperature.
6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
10. Integral Visual-Indicating Light: LED type, indicating detector has operated.

C. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.
2. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot when tested according to UL 268A.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
 - a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.9 HEAT DETECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Faraday.
 2. Fire-Lite Alarms, Inc.; a Honeywell International company.
 3. Notifier.
 4. Siemens Industry, Inc.; Fire Safety Division.
 5. Silent Knight.
 6. SimplexGrinnell LP.
- B. General Requirements for Heat Detectors: Comply with UL 521.
 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- C. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Wheelock.
 2. GE UTC Fire & Security; A United Technologies Company.
 3. Gentex Corporation.
 4. Siemens Industry, Inc.; Fire Safety Division.
 5. SimplexGrinnell LP.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

- C. Chimes: Vibrating type.
- D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.
- E. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
 - 1. Mounting: Wall mounted unless otherwise indicated.
 - 2. Flashing shall be in a temporal pattern, synchronized with other units.
 - 3. Strobe Leads: Factory connected to screw terminals.
 - 4. Mounting Faceplate: Factory finished, white.

2.11 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - 1. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
 - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - 3. Rating: 24-V ac or dc.
 - 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

2.12 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.13 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall or to circuit-breaker shunt trip for power shutdown.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate solenoids for use in sprinkler service.

2.14 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone lines and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Abnormal test signal.
 - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.15 RADIO ALARM TRANSMITTER

- A. Transmitter shall comply with NFPA 1221 and 47 CFR 90.
- B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.
 - 1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 - 2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
 - 3. Normal Power Input: 120-V ac.
 - 4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 - 5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
 - 6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 - 7. Antenna-Cable Connectors: Weatherproof.
 - 8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
- C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
 - 1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 - 2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 - 3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 - 4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 - 5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 - 6. Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
- C. Equipment Mounting: Install fire-alarm control unit on finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- F. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.
- G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
- H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- K. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

- L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 PATHWAYS

- A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
 - 1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
- B. Pathways shall be installed in EMT.
- C. Exposed EMT shall be painted red enamel.

3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to elevator recall system and components.
 - 5. Alarm-initiating connection to activate emergency lighting control.
 - 6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 7. Supervisory connections at valve supervisory switches.
 - 8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 9. Supervisory connections at elevator shunt-trip breaker.
 - 10. Supervisory connections at fire-extinguisher locations.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

**DIVISION 31
EARTHWORK**

SECTION 311000 - SITE CLEARING

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. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above- and below-grade site improvements.
 - 6. Disconnecting, capping or sealing, and removing site utilities.
 - 7. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically 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 and is the zone where plant roots grow.
- D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other 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.

1.5 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 videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT 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 traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated by the Owner.
- C. Utility Locator Service: Notify "One Call" for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures 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.
- H. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
 - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches above the ground.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 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 Storm Water Pollution Prevention Plan (SWPPP).
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to requirements on the Drawings.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- C. Excavate for and remove underground utilities indicated to be removed.

3.5 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, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 3. Use only hand methods 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.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches 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 more 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. 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 protection zones.
 - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.7 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.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 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.

END OF SECTION 311000

DIVISION 32
EXTERIOR IMPROVEMENTS

SECTION 32 12 16 - ASPHALT PAVING

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. Hot-mix asphalt patching.
 - 2. Hot-mix asphalt paving.
 - 3. Pavement-marking paint.
- B. Related Sections:
 - 1. Section 312000 "Earth Moving" for aggregate subbase and base courses.

1.3 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
 - 1. Job-Mix Designs: For each job mix proposed for the Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each paving material, from manufacturer.
- B. Material Test Reports: For each paving material.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT 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 Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

2.3 AUXILIARY MATERIALS

- A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
 - 1. Color: As indicated on the plans.
- B. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 6-1/2 inches high by 8 inches wide by 84 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 30-inch minimum length.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, 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."
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
 - a. Base Course: 1-1/2 inch.
 - b. Surface Course: 3/4 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 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 25 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into

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: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving 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. Patching: 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.

3.3 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

3.4 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 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 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. 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.

3.5 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.

3.6 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 2950 for surface course, and 95 percent of reference laboratory density for base course.
- 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.

3.7 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. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.

3.8 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 7 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.9 WHEEL STOPS

- A. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.10 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. 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.

3.11 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 32 13 13 - CONCRETE PAVING

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. Driveways.
- 2. Parking lots.
- 3. Curbs and gutters.
- 4. Walks.

- B. Related Sections:

- 1. Section 033000 "Cast-in-Place Concrete for general building applications of concrete.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

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

- B. Other Action Submittals:

- 1. 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer.

- B. Material Certificates: For the following, from manufacturer:

- 1. Cementitious materials.
- 2. Admixtures.

3. Curing compounds.

C. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

1.6 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.
- 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. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.7 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 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.
- 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.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- B. 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.
- C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- D. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.
- E. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars 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.
- G. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- H. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, gray portland cement Type I/II.
- B. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1-inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.

- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

2.6 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
 - 1. Color: As indicated on the plans.

2.7 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 6-1/2 inches high by 8 inches wide by 84 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4 inch in diameter, 30-inch minimum length.

2.8 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 meet or exceed requirements.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): 4000 psi.
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
- C. 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: 4-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
 2. Air Content: 4-1/2 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
 3. Air Content: 5 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.9 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below 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 25 tons.
 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 "Earth Moving."

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- 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 if 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. 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.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

2. Provide tie bars at sides of paving strips where indicated.
 3. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length are required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or another temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Control Joints: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control 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.
- E. 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.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

- F. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- G. Screed paving surface with a straightedge and strike off.
- H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- I. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- 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.
- K. Cold-Weather 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.
- L. Hot-Weather 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.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.

- B. Float Finish: Begin the second floating operation when bleed-water 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.

3.8 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 moisture curing as follows:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/2 inch.
 - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
 - 5. Lateral Alignment and Spacing of Dowels: 1 inch.
 - 6. Vertical Alignment of Dowels: 1/4 inch.
 - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
 - 8. Joint Spacing: 3 inches.
 - 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 10. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 WHEEL STOPS

- A. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel 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 of composite samples of fresh concrete obtained according to ASTM C 172 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, 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: 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 REPAIRS 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 323223 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes single- and multiple-depth segmental retaining walls with and without soil reinforcement.
- B. Related Requirements:
 - 1. Section 312000 "Earth Moving" for excavation for segmental retaining walls.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each color and texture of concrete unit specified.
- C. Delegated-Design Submittal: For segmental retaining walls.

1.3 INFORMATIONAL SUBMITTALS

- A. Research/Evaluation Reports: For segmental retaining wall units and soil reinforcement, from ICC-ES.
- B. Preconstruction test reports.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:
 - 1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
 - 2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.
- B. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.
- C. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."

2.2 SEGMENTAL RETAINING WALL UNITS

- A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch (1.6 mm) from specified dimension.
- B. Retain first subparagraph below for projects in areas where walls are subject to freezing.
 - 1. Provide units that comply with requirements in ASTM C 1372 for freeze-thaw durability.
- C. Color: As selected by Architect from manufacturer's full range.
- D. Shape and Texture: Provide units matching basic shape, dimensions, and face texture of basis-of-design product.

2.3 INSTALLATION MATERIALS

- A. Pins and Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
- B. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
- C. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base drainage course.
- D. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course.
- E. Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.
- F. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

- G. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.
 - 1. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
 - 2. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
- H. Subdrainage Pipe and Filter Fabric: Comply with requirements in Section 334600 "Subdrainage."
- I. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement.

PART 3 - EXECUTION

3.1 RETAINING WALL INSTALLATION

- A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
 - 1. Lay units in bond pattern indicated.
 - 2. Form corners and ends by using special units.
- B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.
- C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.
 - 1. Tamp units into leveling base as necessary to bring tops of units into a level plane.
- D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
- E. Cap Units: Place cap units and secure with cap adhesive.

3.2 FILL PLACEMENT

- A. General: Comply with requirements in Section 312000 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide," and with segmental retaining wall unit manufacturer's written instructions.
- B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
- C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches (1200 mm) of wall, or one-half of height above bottom of wall, whichever is greater.
 2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.
 - a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
 3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."
- D. Place drainage geotextile against back of wall, and place layer of drainage fill at least 12 inches (300 mm) wide behind drainage geotextile to within 12 inches (300 mm) of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.
- E. Place a layer of drainage fill at least 12 inches (300 mm) wide behind wall to within 12 inches (300 mm) of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.
- F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated.
- G. Place impervious fill over top edge of drainage fill layer.
- H. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches (200 mm) into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
 2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
 3. Do not dump fill material directly from trucks onto geosynthetics.
 4. Place at least 6 inches (150 mm) of fill over reinforcement before compacting with tracked vehicles or 4 inches (100 mm) before compacting with rubber-tired vehicles.
 5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.
1. each 12 inches (300 mm) of fill depth and each 50 feet (15 m) or less of segmental retaining wall length.

END OF SECTION 323223

DIVISION 33
UTILITIES

SECTION 334100 - STORM UTILITY DRAINAGE 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. Pipe and fittings.
2. Junction boxes.
3. Stormwater inlets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
 2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of pipe and fitting, from manufacturer.
- B. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.
- D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

- A. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 1. Soil tight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 JUNCTION BOXES

- A. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated on the plans, with provision for joint sealants.
 - 1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.
 - 2. Steps: Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of junction box to finished grade is less than 60 inches.
 - 3. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

2.3 STORMWATER INLETS

- A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to plans.
- B. Grate Inlets: Made with horizontal grate opening, of materials and dimensions according to plans. Include heavy-duty frames and grates.
- C. Area Inlets: Made with vertical openings, of materials and dimensions according to plans. Include heavy-duty frames and grates.
- D. Frames and Grates: Heavy duty, according to plans.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install junction boxes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of micro tunneling.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping with 12-inch minimum cover.
 - 3. Install PE corrugated sewer piping according to ASTM D 2321.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 2. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 JUNCTION BOX INSTALLATION

- A. Construct junction boxes to sizes and shapes indicated.
- B. Set frames and covers to elevations indicated.

3.5 STORMWATER INLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Install outlets that spill onto grade, anchored with concrete, where indicated.
- C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- D. Construct energy dissipaters at outlets, as indicated.

3.6 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.7 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 IDENTIFICATION

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.

5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.

3.10 CLEANING

- A. Clean interior of piping of dirt and superfluous materials

END OF SECTION 334100

**PRELIMINARY
REPORT OF GEOTECHNICAL EXPLORATION
JKV MEADOWS PHASE II AND III
LEE'S SUMMIT, MISSOURI**

Presented to:

JOHN KNOX VILLAGE

Attn: Mr. Eric Scott

Prepared by:

Otto J. Kruger, Jr., P.E.
Tadele M. Akalu

KTI
Lenexa, Kansas

KTI Project No. 220057G

May 7, 2020

KRUGER TECHNOLOGIES, INC.

GEOTECHNICAL ■ ENVIRONMENTAL ■ TESTING ■ INSPECTION
8271 MELROSE DRIVE ■ LENEXA, KANSAS 66214 ■ VOICE 913-498-1114 ■ FAX 913-498-1116 ■ EMAIL
KTIKC@KTIONLINE.COM

May 7, 2020

Mr. Eric Scott
Director of Operation and Development
John Knox Village
602 N. W. Prior Road
Lee's Summit, MO 64081

Re: KTI Project No. 220057G- PRELIMINARY
JKV-Meadows Phase II and III
Lee's Summit, Missouri

Dear Mr. Scott:

KTI is submitting the preliminary subsurface exploration and geotechnical report for the above referenced project. The purpose of this preliminary report is to describe the surface and subsurface conditions encountered at the site, analyze and evaluate this information, and prepare a summary of existing conditions, subsurface material characteristics, and geotechnical design recommendations so that the design team has sufficient geotechnical information to develop the preliminary design elements of the project. The final report will be developed and presented after feedback from the design team has been given.

We thank you for the opportunity to work with John Knox Village. If you have any questions, please contact us at 913.498.1114.

Respectfully submitted,
Kruger Technologies, Inc.

Otto J. Kruger, Jr., P.E.
Missouri: 23994

Tadele M. Akalu
Laboratory Manager

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**PRELIMINARY
REPORT OF GEOTECHNICAL EXPLORATION
JKV MEADOWS PHASE II AND III
LEE'S SUMMIT, MISSOURI**

AUTHORIZATION

The following table presents the authorization documentation history for the work performed and presented in this report by Kruger Technologies, Inc.

Project: JKV-Meadows Phase II and III Lee's Summit, Missouri		
Document:	Date:	Requested/Provided:
Request for Proposal	3-4-20	Eric Scott – John Knox Village
KTI Proposal 20GT050	3-6-20	Dylan Kruger – Kruger Technologies, Inc.
Notice to Proceed	3-31-20	Eric Scott – John Knox Village

PURPOSE AND SCOPE

The purpose of this investigation was to explore the surface and subsurface conditions present within the site and provide recommendations regarding the following:

- Seismic Considerations
- Site Preparation and Engineered Fill
- Shallow Building Foundations Options
- Slab on Grade
- Surface and Subsurface Drainage
- Excavation Considerations
- Trench Backfill Recommendations
- Manhole/Inlet Structure Backfill Recommendations
- Pavement Recommendations

SITE DESCRIPTION

The project site is located on the east side of NW Shamrock Avenue and west side of NW Peace Pkwy in Lee's Summit, Missouri, the location of the existing John Knox Village Meadows. At the time of investigation, the majority of the Phase II site had multiple single-story buildings, paved parking lots, large trees and was otherwise grass covered. The Phase III site was undeveloped and grass covered with significant grade change across the site. There are existing utilities on all sides of the site.

PROJECT DESCRIPTION

At the time of the field investigation there was only general building configuration available. We understand that the current intent for the project consists of the design and construction of two multi-story (probably 4-story stepping down to 3-story) apartment buildings at the existing John Knox Village facility in Lee's Summit, Missouri. It is our understanding that the new Phase II and III buildings will be at grade structures. In addition, Phase II will have underground parking. We understand that both Phase II and III buildings will tie into the existing building. Boring elevations were determined by BHC Rhodes through contracting by the client.

FIELD EXPLORATION PROCEDURES

A total of eighteen test borings, eight borings for Phase II represented by borings B-1 through B-8, eight borings for Phase III represented by borings B-9 through B-16 and two borings for the new parking lot represented by B-17 and B-18 were completed for the above referenced project on April 21, 2020. The boring locations were selected by KTI. Field staking, including horizontal locations and elevations were determined by BHC Rhodes through contracting by the client.

The borings in the proposed building footprint and parking lot areas were drilled using a track mounted CME-55 drill rig. Advancement of the test holes was accomplished using 4-inch O.D continuous flight augers, soil sampling was performed by hydraulically pushing thin wall steel (Shelby) tubes and Standard Penetration Test (SPT).

Site soils were visually and manually classified in general accordance with ASTM D 2488 by the drill crew chief as drilling progressed. All the soil samples were delivered to the laboratory for verification of the field classifications. The boring logs were created as the borings were advanced and supplemented with information from lab test results. The boring logs are attached in Appendix I. In addition, boring profiles have been attached showing the relative relationship of surface and top-of-rock elevations at the sites.

LABORATORY TESTS

Laboratory tests were performed on the recovered samples to determine the engineering characteristics and for additional verification of the field classifications in accordance with ASTM D 2487. The results of these tests, including in-situ moisture content, dry density, plasticity (Atterberg Limits), and unconfined compressive strength of soil are presented in Appendix II.

GEOLOGY/SUBSURFACE CONDITIONS

The general profile of site soils consists of topsoil, fill and natural clay soils. Highly weathered shale bedrock was encountered within 5.0 to 12.5-foot depths from existing surface elevation during the exploration with auger refusal on slightly weathered limestone occurring in the building footprints at depths ranging from 5.5 to 16.2 feet below existing grade. The majority of the top 1 foot was topsoil. This was underlain by fill material from 1.0 to 3.0 feet consisting of fat clays and trace organics. The natural clay site soils from 3.0 to 12.5 feet are generally comprised of high plasticity (fat) clays. The underlying existing materials are highly weathered shale underlain by weathered limestone. The existing natural clay soils are generally moist and exhibit medium stiff to stiff consistency. The Unified Soil Classification System classifies low plasticity (lean) clay soils as CL and high plasticity (fat) clay soils as CH. All the test borings were terminated at auger refusal and the bedrock at this depth appears to be slightly weathered limestone.

During advancement of the borings, free water was not encountered in any of the test borings. It should be noted that water level determinations made in relatively impervious (clay) soils might not present a reliable indication of the actual water table. However, water level determinations made in relatively pervious (sand/silt) soils are considered an accurate indication of the water table at the time that those measurements are made. Fluctuations in the water table should be expected with changing seasons and annual differences.

DESIGN CRITERIA AND RECOMMENDATIONS

Laboratory test results of the recovered samples showed the following characteristics that were used as criteria for determining the recommendations for bearing values and design data:

In-Situ Moisture	17.0 to 35.0%
Dry Density.....	89.4 to 110.1 pcf
Liquid Limit	55 to 79
Plasticity Index	33 to 56
Unconfined Compressive Strength	2,208 to 5,261 psf

Seismic Considerations

Based on the International Building Code (IBC) Section 1615.1.1, the subsurface stratigraphy, and the use of shallow foundations bearing on existing site bedrock, the general Site Class Definition for the structures bearing on soil is Site Class B.

Site Preparation and Engineered Fill

A site grading plan was not available at the time of exploration; however, based on the site topography minimal cuts and fills would be anticipated.

Areas to receive fill should be stripped of vegetation, topsoil, pavement, and any other deleterious materials. Any isolated areas of soft or deleterious materials encountered at subgrade elevation should be removed and replaced with engineered fill. The moisture content of the subgrade soils should be appropriate to achieve the required compaction.

Proper drainage of the construction area should be provided to protect foundations, floor slabs, and pavement subgrades from the detrimental effects of weather conditions. Excavations should be kept as dry as possible. Any loose or soft materials which accumulate or develop on subgrade or bearing surfaces should be removed prior to the placement of concrete or pavement sections. Concrete should be placed in footing excavations as soon as possible after excavations are complete.

Trucks and other heavy construction vehicles should be restricted as much as possible from trafficking on the finished subgrade in the building to prevent unnecessary disturbances of subgrade soils. Excessive rutting or pumping of the subgrade could occur from construction traffic, particularly during periods of wet weather. If such disturbed areas develop, the subgrade may have to be excavated and replaced with properly compacted fill.

Concrete for foundations should be placed as soon after completion of the excavations as possible to avoid disturbance of the bearing material by inflow of surface water, groundwater, or precipitation.

Supplemental engineered fill should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and

the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Engineered fill should be compacted to a minimum of 95 percent of maximum density as determined by ASTM D698 (standard Proctor test) at moisture content between 0 and 4 percent above optimum moisture for high plasticity clay material and from -2 to +2 from optimum moisture content for low plasticity clays. The existing site soils cannot be used for fill material as they do not meet the requirements presented in the Building Pad Fill or Parking Lot Fill sections below.

The fill should be benched in any sloped areas greater than one vertical to five horizontal in order to maintain relatively horizontal lifts. The benching should be placed at not less than 12-inch rises over those areas where it is required as the work is brought up in layers.

Building Pad – The soils encountered on site below one foot from existing grade are classified as unacceptable for use as LVC below slab on grade and pavement subgrade due to the high plasticity characteristic of the natural clay. Material used in the top 18 inches of the building pad should be a low volume change (LVC) material. Acceptable LVC material is any soil type that has a Liquid Limit (LL) of less than 45 and a Plasticity Index (PI) of less than 25. Crushed rock or sand materials are also considered to be LVC material. The soils encountered on site do not meet the requirements for LVC material.

General Foundation Options for Phase II & III

Finished floor elevations were not determined at the time of this report preparation. We believe that foundations bearing on rock is the preferred option for this project. Sufficient bearing rock is available at relatively shallow depths but there is also dramatically varying rock surface elevations across the proposed building footprints. Specific final foundation recommendations will be given when final floor elevations and building configurations are provided. A combination of shallow and deep foundation systems may be utilized on this project depending on the finish floor and type of building configurations. Shallow spread footings founded in the competent limestone bedrock below the weathered zone could be proportioned for maximum bearing pressures of 10 ksf. Based on previous experience with the local geology, footings extending into the limestone bedrock may encounter localized variations such as vertical clay-filled joints. Where vertical joints are encountered within the influence of the footings, over excavation of the soft clay/shale infill materials and cleaning of the joint walls would be required. The pattern of vertical joints should be apparent after the building is excavated to or below planned subgrade level. In general, vertical

joints should be cleaned to a minimum depth equal to the horizontal width of the joint. However, this is only a generalization. The extent of over excavation/cleaning of vertical joints will be highly dependent on several factors, including the joint width, location/orientation of the joint(s), and footing size and should be adjusted as required by the geotechnical engineer or engineering technician. Following over excavation and cleaning of the joint sidewalls, and approval by the geotechnical engineer, the joints should be backfilled to the top of joint with concrete (e.g., either structural concrete, or lean concrete with a minimum 28-day strength of 2,000 psi).

An option for a deep foundation system would consist of grade beams supported by drilled, cast-in-place concrete shafts bearing in the competent limestone using an allowable contact stress of 40 ksf. In order to achieve this competent limestone material, the drilled shafts will need to penetrate approximately 1 foot into the overlying bedrock materials consisting of highly weathered limestone. Regarding drilled shafts, we anticipate that the majority of the limestone formation can be drilled out with a rock auger or core bucket. However, competent and harder beds of limestone will likely require the use of a core barrel. A drilled shaft foundation system supported by limestone bedrock will result in essentially no settlement of the new structure. Lateral resistance of deep foundation elements is dependent upon structural design, embedment length, and soil conditions. The pier must remain in contact with the undisturbed materials or engineered fill as long as a lateral load condition exists. No allowances for negative skin friction on drilled shafts were considered in generating capacity recommendations for deep foundations. All deep foundation installation should be inspected by representatives of KTI.

Slab on Grade

For slab on grade subgrade it is recommended that the top 18 inches of subgrade directly below the slab be a low swell potential material or low volume change material (LVC). **The majority of site soils from 1 foot to 3 feet below the FF elevation do not meet the requirement for LVC material and should not be used directly below the slab.** We recommend over excavation replacement of the upper 18 inches of subgrade (in addition to a capillary break material comprised of clean crushed rock) with low swell material such as MODOT Type-5 or KDOT AB-3.

Movement between slabs on grade and walls may occur. To minimize the effects of this movement, we recommend that slip joints be incorporated between all slabs and walls. All slabs should contain crack control and construction joints, which are formed on 15 to 25-foot centers,

each way, or as designed by the project structural engineer. To prevent moisture movement through the slab on grade, it is recommended that a capillary moisture barrier be placed under the slabs. This barrier should be a minimum of a 6-inch thick layer of clean granular material extending to the limits of the foundation walls. Should additional moisture protection be desired, it should consist of 6-mil polyethylene sheeting placed between the slab and the base course. The use of clean gravel for a capillary break or polyethylene would not be necessary if another form of moisture protection is planned to be used. Appropriate consideration of slab curing for this condition should be undertaken. For the purpose of slab design, a modulus of subgrade reaction (k) of 100 pounds/cubic inch is suggested for a subgrade consisting of well-compacted, plastic clay fill and a modulus of subgrade reaction (k) of 200 pounds/cubic inch is suggested for a subgrade consisting of compacted well graded aggregate or modified site soils. Actual slab thickness will depend on anticipated loading but is not recommended to be less than 4 inches.

Surface Drainage

In order to reduce the problems related to water infiltration, it is recommended that the final grade around the structure perimeters have a positive slope extending at least six feet away from the structure. Backfill of soils around the foundation should be compacted at a minimum of 95 percent of maximum dry density at moisture content between optimum and four percent above optimum in accordance with ASTM D 698.

Excavation Considerations

We believe that the project soils are Type B as classified in the OSHA Excavation Standard Handbook 29 CFR Parts 1926.650 through 1926.652. Type B soils are characterized by cohesive soils above the water table with unconfined compressive strengths greater than 0.5 tons per square foot (tsf) but less than and 1.5 tsf. Type B soils include any fill soils meeting or exceeding the above criteria, as well as undisturbed soils with unconfined compressive strengths of >1.5 tsf which are subject to vibration from traffic. Temporary excavation slopes for Type B soils can be one horizontal to one vertical with a maximum excavation depth of 20 feet.

Excavations deeper than 20 feet may require the use of supplemental shoring and will require the preparation of an excavation design prepared by a registered professional engineer.

Excavation of trenches may extend into the weathered bedrock materials. Excavation of the upper zones of the weathered bedrock material may be performed with conventional excavation

equipment. At borings and elevations where auger refusal was encountered, additional effort may be required to excavate the weathered bedrock materials (i.e. rock hammer, etc.).

Trench Backfill

According to our findings, excavated site materials may be used as backfill for trench excavation. Backfill should not be placed on soft materials or frozen ground. Soil backfill overlying the bedding should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Trench backfill under driveways/parking lots should be compacted to a minimum of 95 percent of maximum density as defined by Standard Proctor (ASTM D 698) at moisture content according to the recommendations presented in the Site Preparation and Engineered Fill section of this report. In common yard areas, the soil backfill should be compacted to a minimum of 90 percent of maximum density (ASTM D 698) using the above moisture parameters. After preparation of the trench bottom, a pipe bed of a minimum of 6" shall be prepared using crushed stone or crushed gravel meeting the following requirements:

<u>Nominal Pipe Size Diameter</u>	<u>AASHTO M43 Size</u>
15" or Less	67, 7, 8 or washed #9
Greater than 15"	57, 6, or 67

Manhole/Inlet Structure Backfill

Soil backfill around structures should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Backfill should be compacted to a minimum of 95 percent of maximum density as defined by Standard Proctor (ASTM D 698) at a moisture content between 0 and 4 percent above optimum moisture (preferred average of plus 2 percent). Another option is to backfill with a Controlled Low Strength Material (CLSM), or flowable fill. The flowable fill should exhibit a minimum unconfined compressive strength of 250 psi after 28 days. Bedding material for manhole/inlet structure should be clean crushed rock conforming to the following gradation:

<u>Sieve Designation</u>	<u>Percent Passing by Weight</u>
1 ½"	100
No. 4	0 – 35
No. 200	0 – 8

PAVEMENT RECOMMENDATIONS

Pavement Subgrade Preparation

Pavement subgrades should be prepared in accordance with the recommendations presented in the SITE PREPARATION and ENGINEERED FILL section of this report. Construction scheduling, involving paving and grading by separate contractors, typically results in a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, and/or wetting of the subgrade between grading and paving can result in deterioration of the previously completed subgrade. A non-uniform subgrade can result in poor pavement performance and local failures relatively soon after pavements are constructed.

The site soils at the anticipated subgrade are highly expansive clays (CH). We recommend the top 12 inches of the subgrade either be removed and replaced with crushed limestone such as MODOT Type-5 or stabilized with 15% of Type-C Flyash, 5% of lime or 6% of lime kiln dust and compacted at 95 percent of maximum dry density per ASTM D698.

The following options for construction of the parking lot are being considered for the project. It is understood that low to moderate levels of truck traffic may be experienced by the proposed parking lot.

Asphaltic Cement Concrete Pavements on Modified Subgrade

Full depth recommended flexible pavement sections including aggregate base are presented in Table 1. The pavement profiles presented below for drive lanes and parking stalls assume only passenger vehicle loading. A heavy-duty pavement section is presented for emergency vehicles and garbage trucks. Passenger vehicles are defined as two-axle, four-wheel vehicles (cars, trucks, vans and SUVs).

Table 1
Asphaltic Cement Concrete Pavement on Modified Subgrade (Minimum)

Material	Parking Stalls	Drive Lanes	Heavy Duty
Surface Course	1.5-inch	2-inch	2-inch
Base Course	2.5-inch	4-inch	6-inch
Aggregate Base	6-inch	6-inch	6-inch

The asphaltic base course should be compacted to a minimum of 95 percent of the mixture's Marshall density, when determined in accordance with ASTM D 6926. The surface course should have a minimum Marshall stability of 1800 pounds and be compacted to a minimum of 97 percent of the mixture's Marshall density, when determined in accordance with ASTM D 6926.

Portland Cement Concrete Pavements on Modified Subgrade

Based on the soil types encountered in the proposed parking lot and previous experience with stabilized subgrade materials a resilient modulus of 200-pci is suggested.

Portland cement concrete (PCC) pavements are recommended for drive approaches; loading dock aprons, trash dumpster pads and approaches, loading/unloading areas, and other areas where heavy wheel loads will be concentrated. We recommend that the concrete pavements in areas receiving heavy truck traffic have a minimum thickness of 8 inches. If PCC pavements are considered for passenger vehicle areas, we recommend a minimum thickness of 5 inches.

It is also recommended that a 4-inch levelling and drainage course of clean, crushed rock be placed below all PCC pavements and that appropriate subdrainage or connection to a suitable gravity outfall be provided to remove water from the drainage layer.

The PCC mixture should be designed to develop a minimum compressive strength of 4000 psi at 28 days with a 4-inch maximum slump and 5 to 7 percent entrained air. Where Portland cement concrete is used, load transfer devices should be installed at all construction joints or post-placement sawed joints.

Construction Considerations

Construction traffic on the pavements has not been considered in the recommended typical sections. If construction scheduling dictates the pavements will be subject to traffic by construction equipment/vehicles, the pavement thickness should be reconsidered to include the effects of the additional traffic loading. Construction traffic should not be allowed on partially completed pavements as the pavements will not have adequate structural capacity and could be damaged.

Periodic maintenance of all of the pavements should be anticipated. This should include sealing of cracks and joints and by maintaining proper surface drainage to avoid ponding water on or near the pavement areas.

Pavement Drainage

The granular section should be graded to adjacent storm sewer inlets or drainage ditches and provisions should be made to provide drainage from the granular section into the storm sewer. Drainage of the granular base is particularly important where two different sections of pavements (such as full-depth asphaltic concrete and Portland cement concrete with aggregate base) abut, so that water does not pond beneath the pavements and saturate the subgrade soils.

The performance of pavements will be dependent upon a number of factors, including subgrade conditions at the time of paving, rainwater runoff, and traffic. Rainwater runoff should not be allowed to seep below pavements from adjacent areas. All pavements should be sloped approximately 1/4 inch per foot to provide rapid surface drainage. Proper drainage below the pavement section helps prevent softening of the subgrade and has a significant impact on pavement performance and pavement life. Therefore, we recommend that a granular blanket drain be constructed at all storm sewer inlets within the pavement areas. The blanket drain should consist of clean, crushed stone aggregate extending a minimum of 6 inches below pavement subgrade level. The blanket drains should extend radially a minimum of 8 feet from each of the storm sewer inlets. The grade within the blanket drain should be sloped toward the storm sewer inlet, and weep holes should be drilled through the inlet to provide drainage of the granular section into the inlet. Placement of geotextile filter fabric across the weep holes could be considered to prevent loss of aggregate through the weep holes. These recommendations are very important for long-term performance of the pavements. Because pavements typically have relatively low

factors of safety, it will be very important that the specifications are followed closely during pavement construction.

Based on our experience with similar projects, irrigation systems are commonly installed in the landscaped areas adjacent to portions of the pavement areas. If such an irrigation system is to be installed, we recommend that consideration be given to installing subsurface drainage lines between irrigated areas and the planned pavements. It has been our experience that the quantity of subsurface seepage originating from irrigated areas can be substantial and can adversely affect the performance of the pavement subgrade. Therefore, consideration should be given to constructing edge drain lines along the pavements located adjacent to irrigated areas, to intercept and divert subsurface water flows from beneath the pavements. These lines should be constructed behind the curb lines, on the upgradient side of the pavements, and should be sloped to provide positive gravity flow to a suitable outfall.

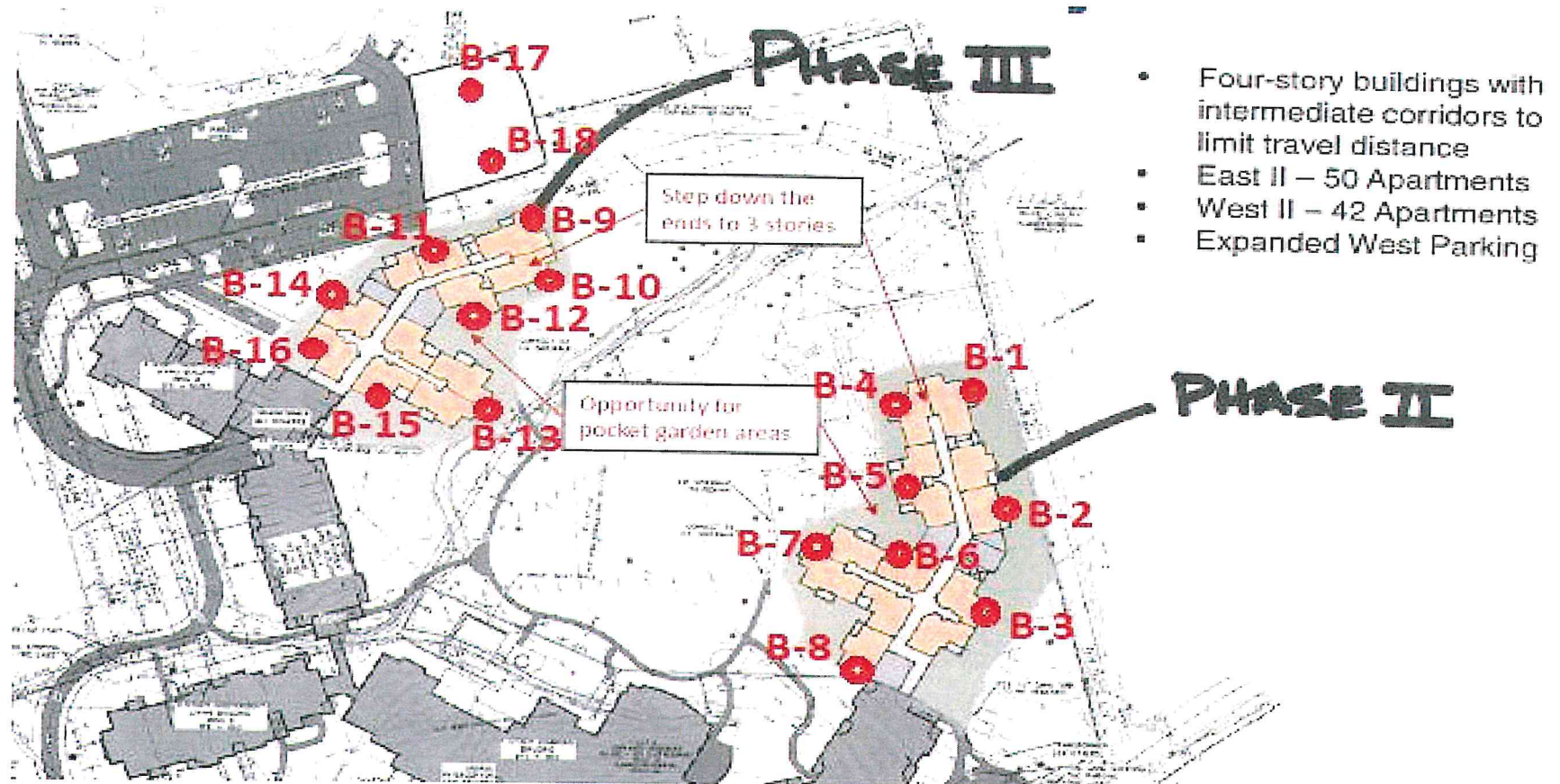
REMARKS

It is recommended that the geotechnical engineer be retained to review the plans and specifications for the project so that an evaluation and comments can be provided regarding the proper incorporation of information from this geotechnical report into the final construction documents. We further recommend that the geotechnical engineer be retained during construction phases for earthwork, pavement, and foundations to provide observation and testing to aid in determining that design intent has been accomplished.

The findings, recommendations, and suggestions contained in this report are our opinions based on data acquired to date and are assumed to be representative of conditions at locations between borings. Due to the fact that the area at the borings is very small relative to the overall site, and for other reasons, we make no statement warranting the conditions below our borings or at other locations throughout the site. In addition, we do not warrant that the general strata logged at the borings are necessarily typical of the remaining areas of the site.

Reports shall not be reproduced except in full, without written approval of KTI. Information in this report applies only to the referenced project in its present configuration and location and shall not be used for any other project or location.

BORING LOCATION DIAGRAM



Boring Location Diagram
JKV-Meadows Phase II and III
Lee's Summit, Missouri

KRUGER TECHNOLOGIES, INC.

Drawn: TMA

Date: 5/5/20

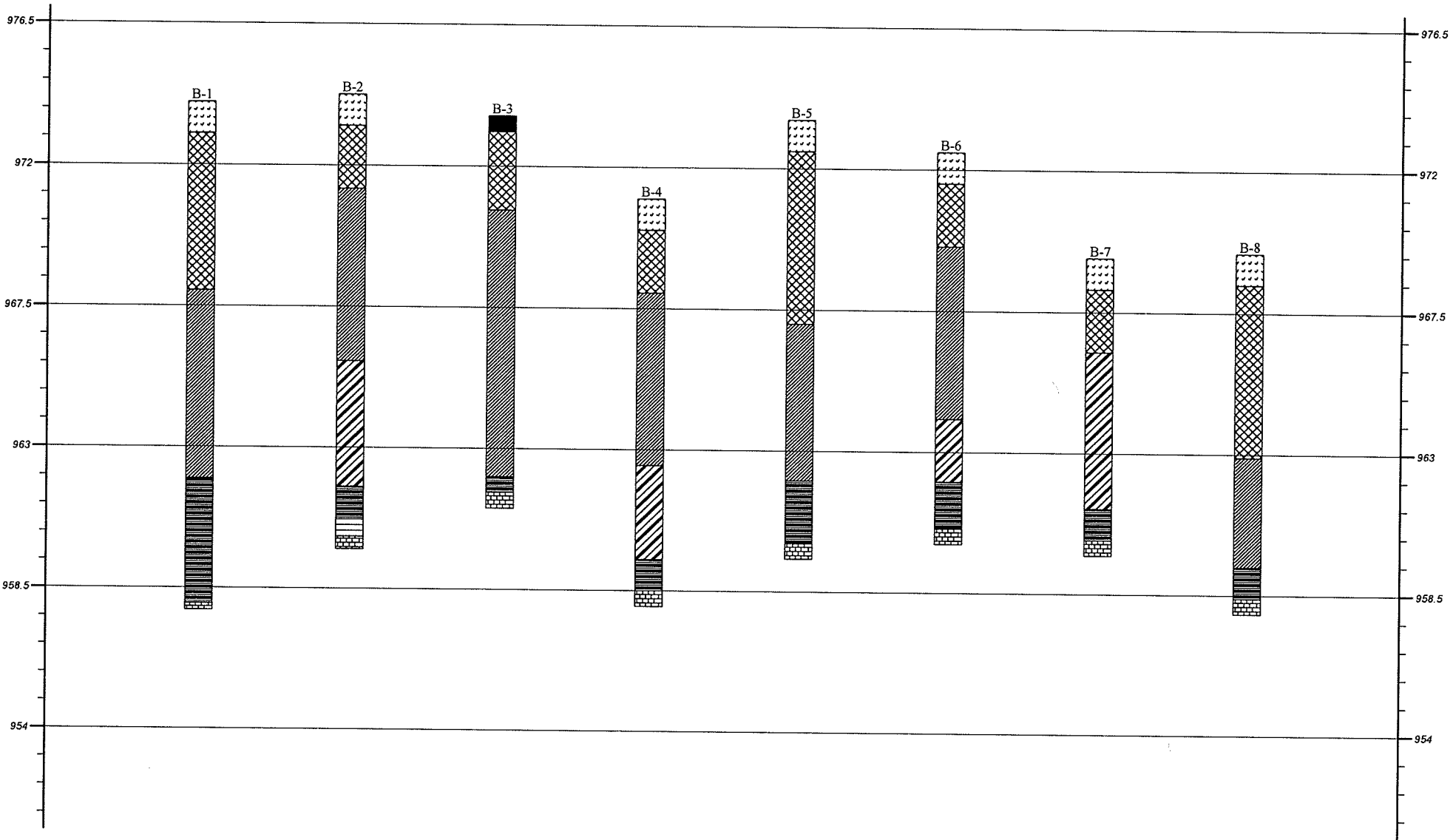
KTI Project No. 220057G

APPENDIX I

Boring Logs

ELEVATION IN FEET

ELEVATION IN FEET

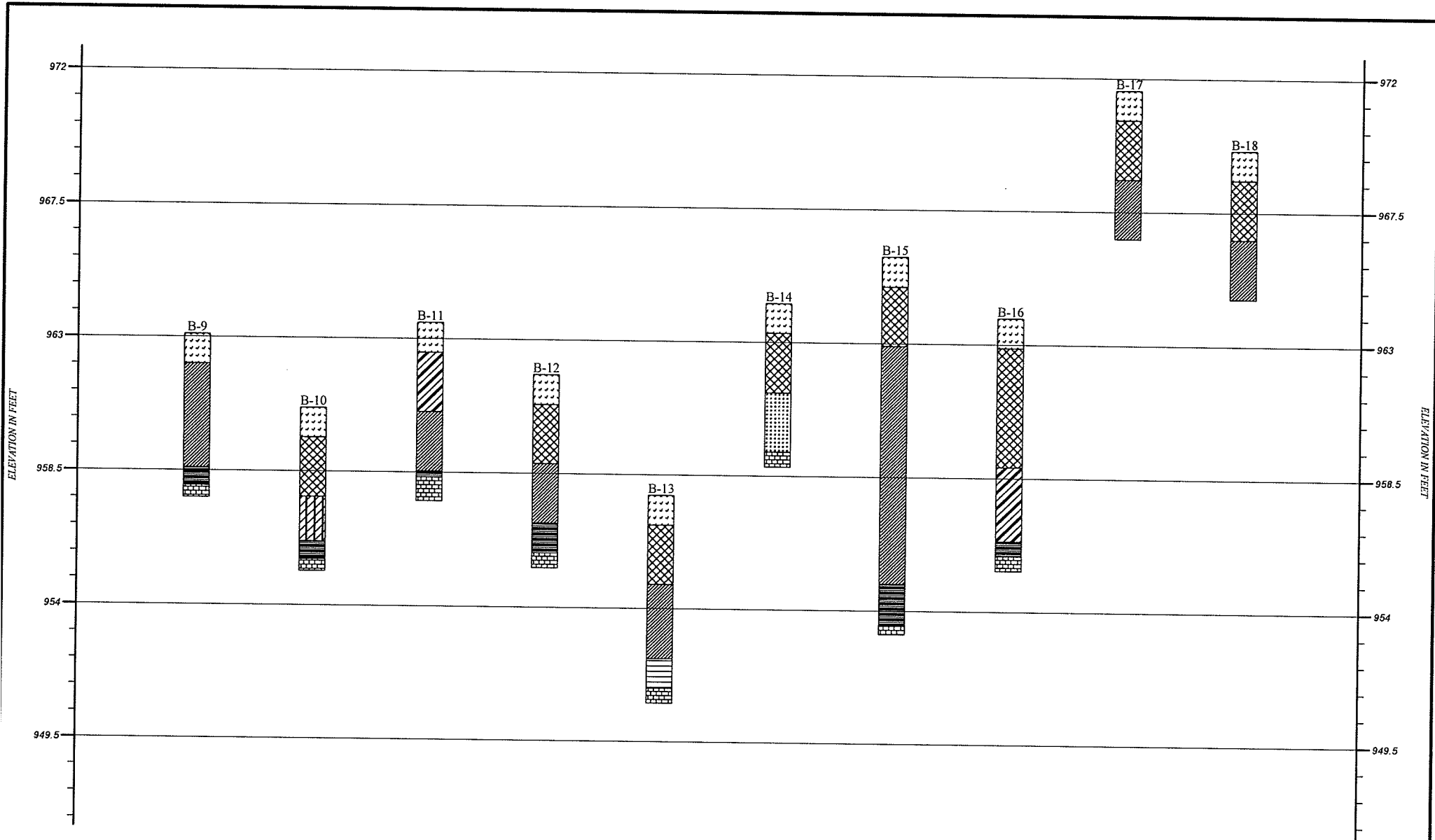


Plan View

Strata symbols

- Topsoil
- Fill
- High plasticity clay
- Weathered
- Limestone
- Low-high plasticity clays
- Shale
- Paving

KRUGER TECHNOLOGIES, INC. GENERALIZED SOIL PROFILE		
HORIZONTAL SCALE:	DRAWN BY/APPROVED BY	DATE DRAWN
VERTICAL SCALE: 1"=4.5'		5/6/2020
JKV-Meadows Phase II		
PROJECT NO. 220057G		FIGURE NUMBER



Plan View

Strata symbols

- Topsoil
- High plasticity clay
- Weathered
- Limestone

- Fill
- Low plasticity clay
- Low-high plasticity clays
- Shale
- Sandstone

KRUGER TECHNOLOGIES, INC.		
GENERALIZED SOIL PROFILE		
HORIZONTAL SCALE:	DRAWN BY/APPROVED BY	DATE DRAWN
VERTICAL SCALE: 1"=4.5'		5/6/2020
JKV-Meadows Phase III		
PROJECT NO. 220057G		FIGURE NUMBER



LOG OF TEST BORING

BORING B-1

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 974.01

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
972.5		FILL	Fill, clay with gravel, stiff, grayish brown, moist	1, ST	99.7	26.5	
2.5							
970		FILL	Fill, fat clay trace gravel, stiff, gray, moist	2, ST	96.8	26.8	5040
5							
967.5		CH	Fat clay, stiff, gray, moist				
7.5							
965		CH	Fat clay, very stiff, gray, moist	1, SS		21.4	
10							
962.5							
12.5		W	Highly weathered shale, gray, moist to dry				
960		W	Weathered shale, hard, gray, moist	2, SS		22.5	
15							
957.5		L	Limestone, weathered				
17.5			Drilling discontinued at auger refusal at 16.2				

Notes:



LOG OF TEST BORING

BORING B-2

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 974.27

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
972.5		FILL	Fill, lean to fat clay, trace organics, stiff, greenish gray, moist	1, ST	95.1	25.6	
2.5		CH	Fat clay, stiff, yellowish brown, moist	2, ST	94.4	29.2	3616
970							
5							
967.5							
7.5							
965		CL-CH	Lean to fat clay, trace sandstone, very stiff, gray & reddish brown, moist	1, SS		23.2	
10							
962.5							
12.5		W	Weathered shale, gray, moist to dry	2, SS			
960		S	Shale, weathered hard, gray, moist to dry				
15		L	Limestone, weathered				
957.5			Drilling discontinued at auger refusal at 14.5 feet				
17.5							

Notes:



LOG OF TEST BORING

BORING B-3

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

DATE: 5/5/2020

ELEVATION: 973.61

FINISH: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		P	Asphalt				
972.5		FILL	Fill, lean to fat clay, with organics, stiff, olive gray, moist	1, ST	100.4	21.1	
2.5							
970			Fat clay, stiff, gray, moist	2, ST	90.6	31.8	3158
5		CH					
967.5							
7.5							
965		CH	Fat clay with weathered sandstone, very stiff, yellowish brown, moist	1, SS		24.2	
10							
962.5							
12.5		W L	Weathered shale, gray, moist to dry Limestone, weathered				
960			Drilling discontinued at auger refusal at 13.0 feet				
15							
957.5							
17.5							

Notes:



LOG OF TEST BORING

BORING B-4

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 971.01

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
970		FILL	Fill, lean to fat clay, with organics, stiff, dark gray, moist	1, ST	98.4	24.7	
2.5			Fat clay, stiff, light gray, moist	2, ST	95.6	28.4	
967.5		CH					
5							
965							
7.5							
962.5		CL-CH	Lean to fat clay, with weathered sandstone, very stiff, gray & reddish brown, moist	1, SS		24.5	
10							
960							
12.5		W	Weathered shale, gray, moist to dry				
		L	Limestone, weathered				
957.5			Drilling discontinued at auger refusal at 13.0 feet				
15							
955							
17.5							

Notes:



LOG OF TEST BORING

BORING B-5

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 973.56

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
972.5		FILL	Fill, lean to fat clay, trace organics, stiff, dark brown, moist	1, ST	97.0	26.5	
2.5							
970		FILL	Fill, lean to fat clay, trace organics, stiff, gray & reddish brown, moist	2, ST	93.8	27.8	
5							
967.5							
7.5		CH	Fat clay, gray, moist				
965							
10							
962.5		W	Weathered shale, gray, moist to dry				
12.5		L	Limestone, weathered				
960			Drilling discontinued at auger refusal at 14.0 feet				
15							
957.5							
17.5							

Notes:



LOG OF TEST BORING

BORING B-6

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving



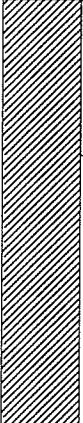



DATE: 5/5/2020

ELEVATION: 972.57

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
972.5 0		TS	Topsoil				
970 2.5		FILL	Fill, lean to fat clay, with organics, stiff, brown & gray, moist	1, ST	96.6	26.8	
967.5 5		CH	Fat clay, stiff, light gray, moist	2, ST	89.4	30.5	
965 7.5		CL-CH	Lean to fat clay, with weathered sandstone, very stiff, gray & reddish brown, moist	1, SS		26.3	
962.5 10		W	Weathered shale, gray, moist to dry				
960 12.5		L	Limestone, weathered				
957.5 15			Drilling discontinued at auger refusal at 12.5 feet				
955 17.5							

Notes:



LOG OF TEST BORING

BORING B-7

PROJECT: JKV-Meadows Phase II and III
CLIENT: John Knox Village
PROJECT NO.: 220057G
START: 4/21/20
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 5/5/2020
ELEVATION: 969.24
FINISH: 4/21/20

LOGGER: TMA
DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
967.5		FILL	Fill, lean to fat clay, trace organics, stiff, dark grayish brown, moist	1, ST			
2.5		CL-CH	Lean to fat clay, very stiff, gray, moist	2, ST			
965							
5							
962.5							
7.5							
960		W	Weathered shale, gray, moist to dry				
		L	Limestone, weathered				
10			Drilling discontinued at auger refusal at 9.5 feet				
957.5							
12.5							
955							
15							
952.5							
17.5							

Notes:



LOG OF TEST BORING

BORING B-8

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 969.41

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
967.5		FILL	Fill, lean to fat clay, trace organics, stiff, grayish brown, moist	1, ST			
2.5							
965		FILL	Fill, fat clay, trace organics, stiff, gray, moist	2, ST			
5							
962.5		CH	Fat clay, yellowish brown, moist				
7.5							
960		W	Weathered shale, gray, moist to dry				
10		L	Limestone, weathered				
957.5			Drilling discontinued at auger refusal at 11.5 feet				
12.5							
955							
15							
952.5							
17.5							

Notes:



LOG OF TEST BORING

BORING B-9

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 963.11

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0							
962.5		TS	Topsoil				
		CH	Fat clay, very stiff, grayish brown, moist	1, ST			
2.5		CH	Fat clay, very stiff, yellowish brown, moist	2, ST			
960							
		W	Weathered shale, very stiff, gray, dry				
5		L	Limestone, weathered				
957.5			Drilling discontinued at auger refusal at 5.5 feet				
7.5							
955							
10							
952.5							
12.5							
950							
15							
947.5							
17.5							
945							

Notes:



LOG OF TEST BORING

BORING B-10

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 960.66

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0							
960		TS	Topsoil				
2.5		FILL	Fill, lean to fat clay, very stiff, dark gray, moist	1, ST			
957.5		CL	Lean clay with weathered sandstone, very stiff, yellowish brown, moist	2, ST			
5		W	Weathered shale, very stiff, gray, dry				
955		L	Limestone, weathered				
			Drilling discontinued at auger refusal at 5.5 feet				
7.5							
952.5							
10							
950							
12.5							
947.5							
15							
945							
17.5							
942.5							

Notes:



LOG OF TEST BORING

BORING B-11

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving



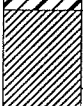

DATE: 5/5/2020

ELEVATION: 963.55

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
962.5		CL-CH	Lean to fat clay, very stiff, reddish brown, moist	1, ST			
2.5							
960		CH	Fat clay with weathered sandstone, very stiff, yellowish brown, moist	2, ST			
5							
957.5		W L	Weathered shale, very stiff, gray, dry Limestone, weathered				
			Drilling discontinued at auger refusal at 6.0 feet				
7.5							
955							
10							
952.5							
12.5							
950							
15							
947.5							
17.5							

Notes:



LOG OF TEST BORING

BORING B-12

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving



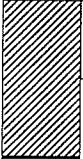


DATE: 5/5/2020

ELEVATION: 961.84

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
960 -2.5		FILL	Fill fat clay with gravel, very stiff, gray, moist	1, ST			
957.5 -5		CH	Fat clay with weathered sandstone, very stiff, yellowish brown, moist	2, ST			
		W	Weathered shale, very stiff, gray, dry				
		L	Limestone, weathered				
955 -7.5			Drilling discontinued at auger refusal at 6.5 feet				
952.5 -10							
950 -12.5							
947.5 -15							
945 -17.5							

Notes:



LOG OF TEST BORING

BORING B-13

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 957.82

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
957.5 0		TS	Topsoil				
955 2.5		FILL	Fill, lean to fat clay with organics, very stiff, gray, moist	1, ST			
952.5 5		CH	Fat clay with weathered sandstone, very stiff, yellow & reddish brown, moist	2, ST			
		S	Shale, very stiff, gray, dry				
		L	Limestone, weathered				
950 7.5			Drilling discontinued at auger refusal at 7.0 feet				
947.5 10							
945 12.5							
942.5 15							
940 17.5							

Notes:



LOG OF TEST BORING

BORING B-14

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving


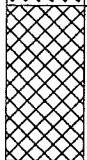
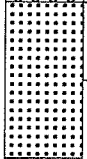

DATE: 5/5/2020

ELEVATION: 964.32

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
962.5		FILL	Fill, lean to fat clay with organics, very stiff, reddish brown, moist	1, ST			
2.5							
960		SA	Silty sandstone, very stiff, yellow & reddish brown, moist to dry	2, ST			
5							
957.5		L	Limestone, weathered				
7.5			Drilling discontinued at auger refusal at 5.5 feet				
955							
10							
952.5							
12.5							
950							
15							
947.5							
17.5							

Notes:



LOG OF TEST BORING

BORING B-15

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 965.92

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
965		FILL	Fill, lean clay with gravel, stiff, brown & grayish brown, moist	1, ST			
2.5							
962.5			Fill, lean to fat clay, stiff, dark brown, moist	2, ST			
5							
960		CH	Fat clay, dark gray, moist				
7.5							
957.5		CH	Fat clay, stiff, gray & dark brown, moistmoist	1, SS			
10		W	Weathered shale, gray, moist to dry				
955							
12.5		L	Limestone, weathered				
952.5			Drilling discontinued at auger refusal at 12.7 feet				
15							
950							
17.5							
947.5							

Notes:



LOG OF TEST BORING

BORING B-16

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

DATE: 5/5/2020

ELEVATION: 963.89

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
962.5		FILL	Fill, limestone screenings, very stiff, light gray, moist	1, ST			
2.5		FILL	Fill, clayey gravel, trace moist, stiff, dark gray, moist	2, ST			
960		FILL	Fill, clayey gravel, trace moist, stiff, dark gray, moist	2, ST			
5		CL-CH	Lean to fat clay, dark gray, moist				
957.5		CL-CH	Lean to fat clay, dark gray, moist				
7.5		W	Weathered sandstone, yellowish brown, moist to dry				
		L	Limestone, weathered				
955			Drilling discontinued at auger refusal at 8.5 feet				
10							
952.5							
12.5							
950							
15							
947.5							
17.5							

Notes:



LOG OF TEST BORING

BORING B-17

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving



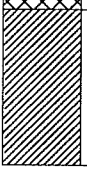
DATE: 5/5/2020

ELEVATION: 971.60

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

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0		TS	Topsoil				
970		FILL	Fill, clayey gravel, stiff, brown, moist				
2.5							
967.5		CH	Fat clay, stiff, olive gray, moist	1, ST			
5			Drilling discontinued at 5.0 feet				
965							
7.5							
962.5							
10							
960							
12.5							
957.5							
15							
955							
17.5							

Notes:



LOG OF TEST BORING

BORING B-18

PROJECT: JKV-Meadows Phase II and III

CLIENT: John Knox Village

PROJECT NO.: 220057G

START: 4/21/20

BORING LOCATION: See Boring Location Plan

METHOD OF DRILLING: 4" Continuous Flight Augers

DEPTH TO - water None

caving

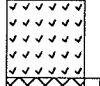
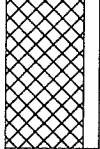
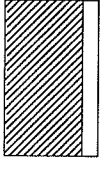
DATE: 5/5/2020

ELEVATION: 969.60

FINISH: 4/21/20

LOGGER: TMA

DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		TS	Topsoil				
967.5 2.5		FILL	Fill, lean to fat clay with organics, stiff, brown & dark gray, moist	1, ST			
965 5		CH	Fat clay, stiff, yellowish brown, moist	2, ST			
962.5 7.5			Drilling discontinued at 5.0 feet				
960 10							
957.5 12.5							
955 15							
952.5 17.5							

Notes:

APPENDIX II

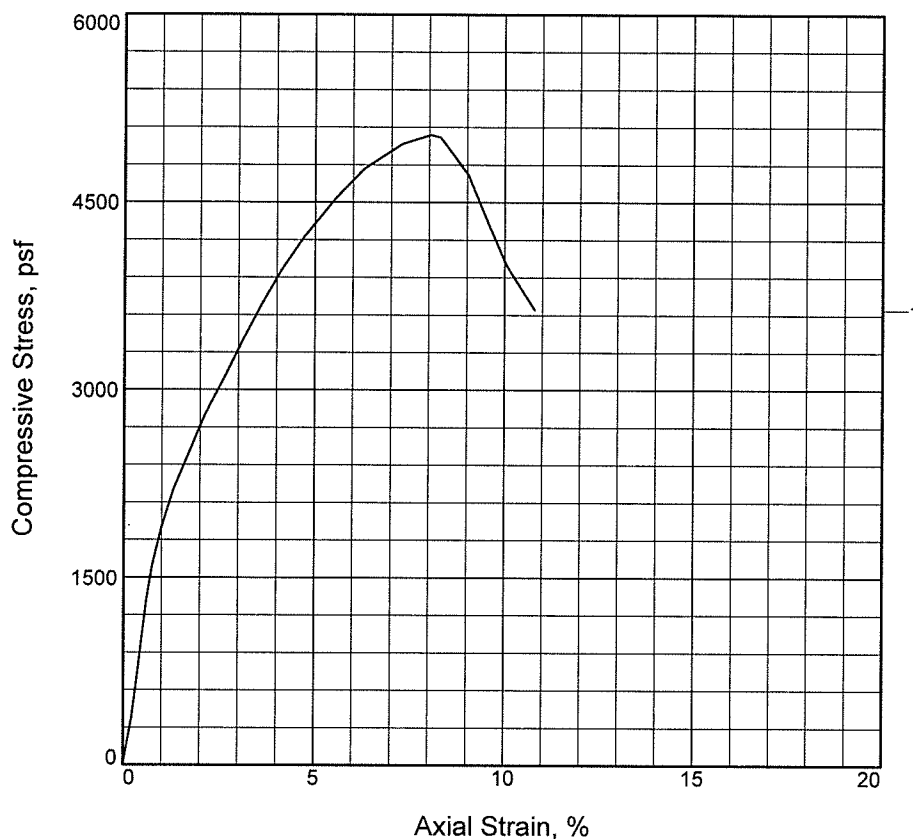
Laboratory Results

SUMMARY OF LABORATORY TEST RESULTS

Boring	Depth (Ft)	Sample No./Type	Natural Moisture %	Natural Dry Density (pcf)	Unconfined Compressive Strength (psf)	Atterberg Limits		Soil Type
						Liquid Limit %	Plasticity Index %	
B-1	1.0-3.0	ST-1	26.5	99.7		79	55	CH
B-1	3.0-5.0	ST-2	26.8	96.8	5040			
B-1	8.5-10.0	SS-1	21.4					
B-1	13.5-15.0	SS-2	22.5					
B-2	1.0-3.0	ST-1	25.6	95.1				
B-2	3.0-5.0	ST-2	29.2	94.4	3616			
B-2	8.5-10.0	SS-1	23.2					
B-3	1.0-3.0	ST-1	21.1	100.4				
B-3	3.0-5.0	ST-2	31.8	90.6	3158			
B-3	8.5-10.0	SS-1	24.2					
B-4	1.0-3.0	ST-1	24.7	98.4				
B-4	3.0-5.0	ST-2	28.4	95.6				
B-4	8.5-10.0	SS-1	24.5					
B-5	1.0-3.0	ST-1	26.5	97.0		70	47	CH
B-5	3.0-5.0	ST-2	27.8	93.8				
B-6	1.0-3.0	ST-1	26.8	96.6				
B-6	3.0-5.0	ST-2	30.5	89.4				
B-6	8.5-10.0	SS-1	26.3					
B-7	1.0-3.0	ST-1	24.9	97.2				
B-7	3.0-5.0	ST-2	28.0	95.4	4130			
B-8	1.0-3.0	ST-1	21.5	105.9				
B-8	3.0-5.0	ST-2	24.7	98.2				
B-9	1.0-3.0	ST-1	21.3	101.0		75	56	CH
B-9	3.0-5.0	ST-2	28.1	96.2	3865			
B-10	1.0-3.0	ST-1	26.0	95.9				
B-10	3.0-5.0	ST-2	26.5	95.7				
B-11	1.0-3.0	ST-1	18.9	110.1				
B-11	3.0-5.0	ST-2	29.9	92.9	2896			
B-12	1.0-3.0	ST-1	22.7	102.8				
B-12	3.0-5.0	ST-2	35.0	89.5				
B-13	1.0-3.0	ST-1	19.6	104.5		61	41	CH
B-13	3.0-5.0	ST-2	27.5	94.0	2748			

Boring	Depth (Ft)	Sample No./Type	Natural Moisture %	Natural Dry Density (pcf)	Unconfined Compressive Strength (psf)	Atterberg Limits		Soil Type
B-14	1.0-3.0	ST-1	22.3	107.0				
B-14	3.0-5.0	ST-2	35.6	89.6				
B-15	1.0-3.0	ST-1	20.1	100.2				
B-15	3.0-5.0	ST-2	21.4	106.4				
B-15	8.5-10.0	SS-1	26.7					
B-16	1.0-3.0	ST-1	28.9	109.1				
B-16	3.0-5.0	ST-2	17.0	97.6	2208			
B-17	3.0-5.0	ST-2	28.4	92.6	4603			
B-18	1.0-3.0	ST-1	29.2	90.4	5261	55	33	CH
B-18	3.0-5.0	ST-2	25.5	96.4				

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	5040			
Undrained shear strength, psf	2520			
Failure strain, %	8.0			
Strain rate, in./min.	0.050			
Water content, %	26.8			
Wet density, pcf	122.8			
Dry density, pcf	96.8			
Saturation, %	96.8			
Void ratio	0.7542			
Specimen diameter, in.	2.84			
Specimen height, in.	5.60			
Height/diameter ratio	1.97			

Description: Fill, fat clay trace gravel, stiff, gray, moist

LL = **PL =** **PI =** **Assumed GS= 2.72** **Type: ST**

Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-1 **Depth:** 3

Sample Number: 2

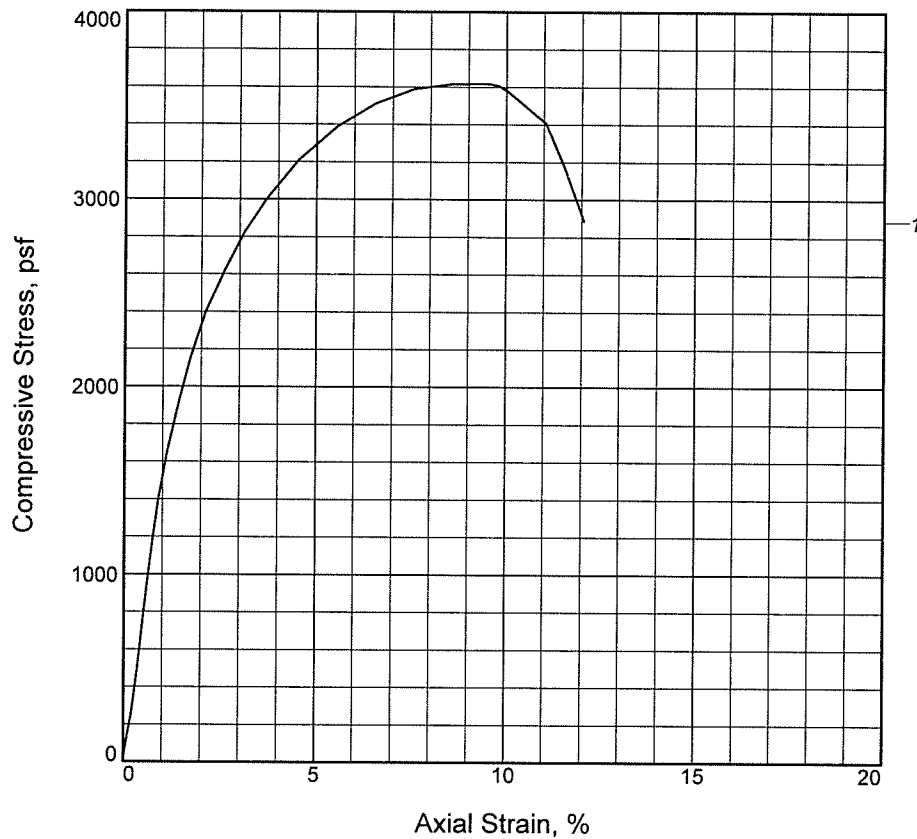


Figure _____

Tested By: TMA

Checked By: OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3616			
Undrained shear strength, psf	1808			
Failure strain, %	9.6			
Strain rate, in./min.	0.050			
Water content, %	29.2			
Wet density, pcf	122.0			
Dry density, pcf	94.4			
Saturation, %	99.4			
Void ratio	0.7991			
Specimen diameter, in.	2.85			
Specimen height, in.	5.60			
Height/diameter ratio	1.96			

Description: Fat clay, stiff, yellowish brown, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST
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Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-2 **Depth:** 3

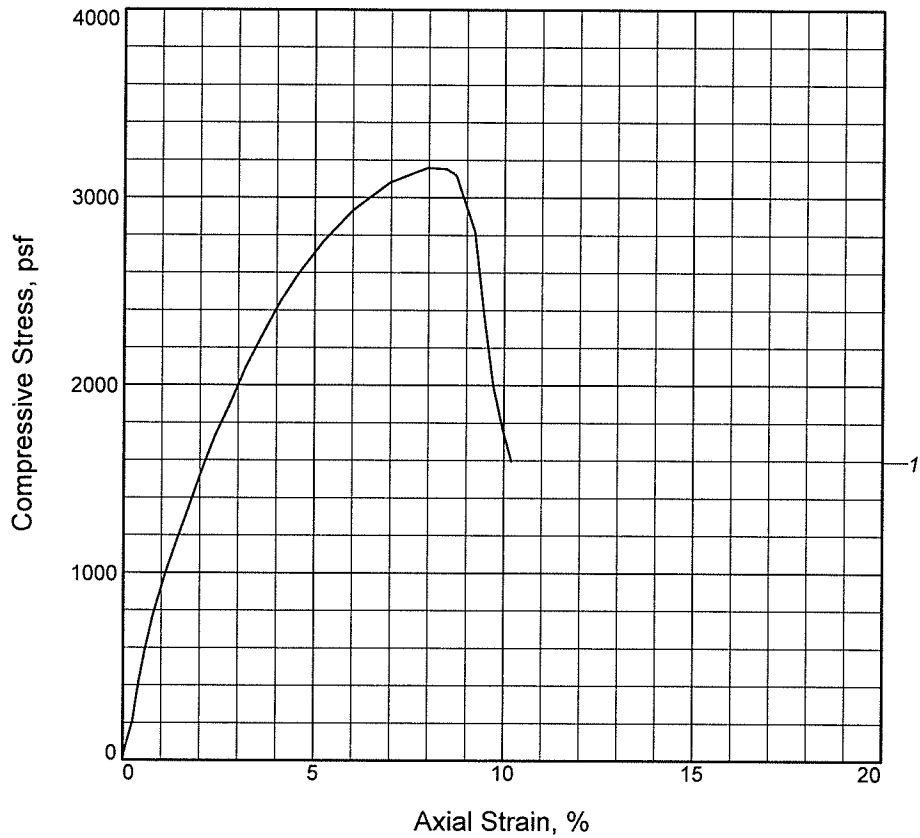
Sample Number: 2

Figure _____



Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3158			
Undrained shear strength, psf	1579			
Failure strain, %	8.0			
Strain rate, in./min.	0.050			
Water content, %	31.8			
Wet density, pcf	119.5			
Dry density, pcf	90.6			
Saturation, %	99.1			
Void ratio	0.8738			
Specimen diameter, in.	2.87			
Specimen height, in.	5.65			
Height/diameter ratio	1.97			

Description: Fat clay, stiff, gray, moist

LL = **PL =** **PI =** **Assumed GS= 2.72** **Type: ST**

Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-3 **Depth:** 3

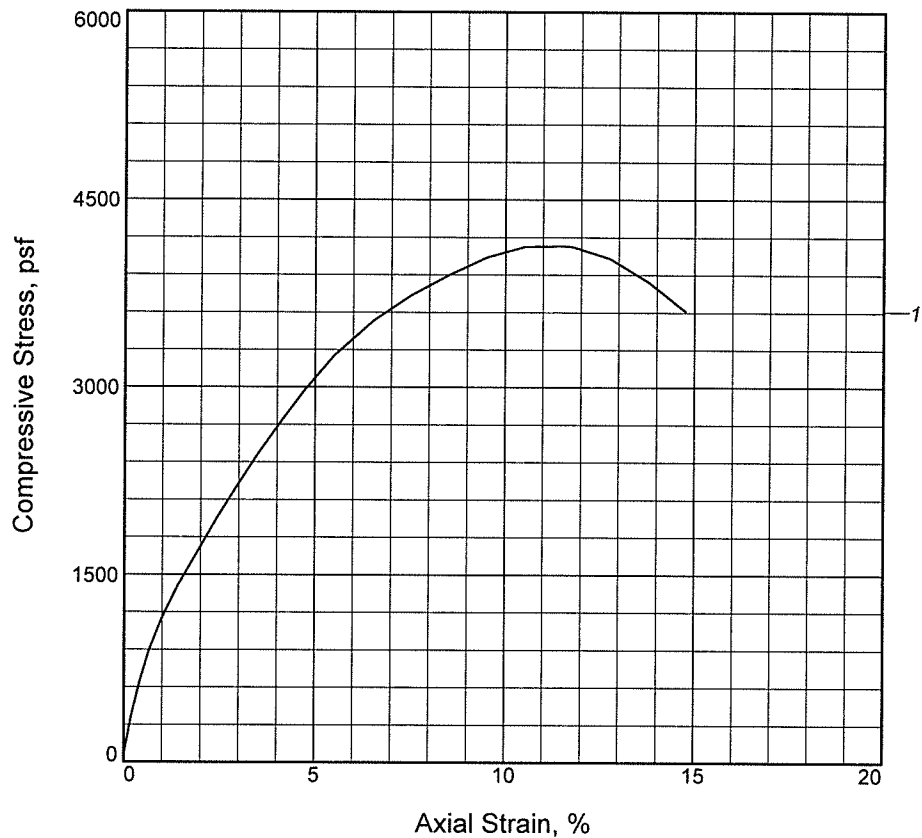
Sample Number: 2



Figure _____

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	4130			
Undrained shear strength, psf	2065			
Failure strain, %	11.5			
Strain rate, in./min.	0.050			
Water content, %	28.0			
Wet density, pcf	122.2			
Dry density, pcf	95.4			
Saturation, %	97.9			
Void ratio	0.7794			
Specimen diameter, in.	2.83			
Specimen height, in.	5.64			
Height/diameter ratio	1.99			

Description: Lean to fat clay, very stiff, gray, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST
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Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-7 **Depth:** 3

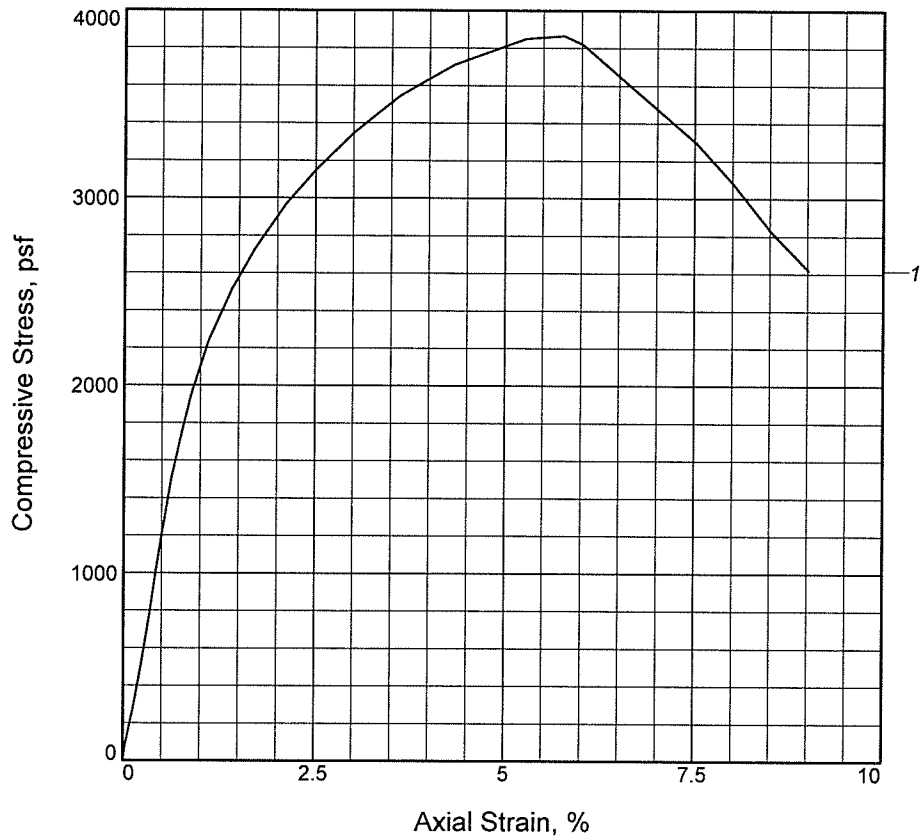
Sample Number: 2

Figure _____

KT

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3865			
Undrained shear strength, psf	1932			
Failure strain, %	5.8			
Strain rate, in./min.	0.050			
Water content, %	28.1			
Wet density, pcf	123.3			
Dry density, pcf	96.2			
Saturation, %	100.0			
Void ratio	0.7649			
Specimen diameter, in.	2.83			
Specimen height, in.	5.60			
Height/diameter ratio	1.98			

Description: Fat clay, very stiff, yellowish brown, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST
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Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-9 **Depth:** 3

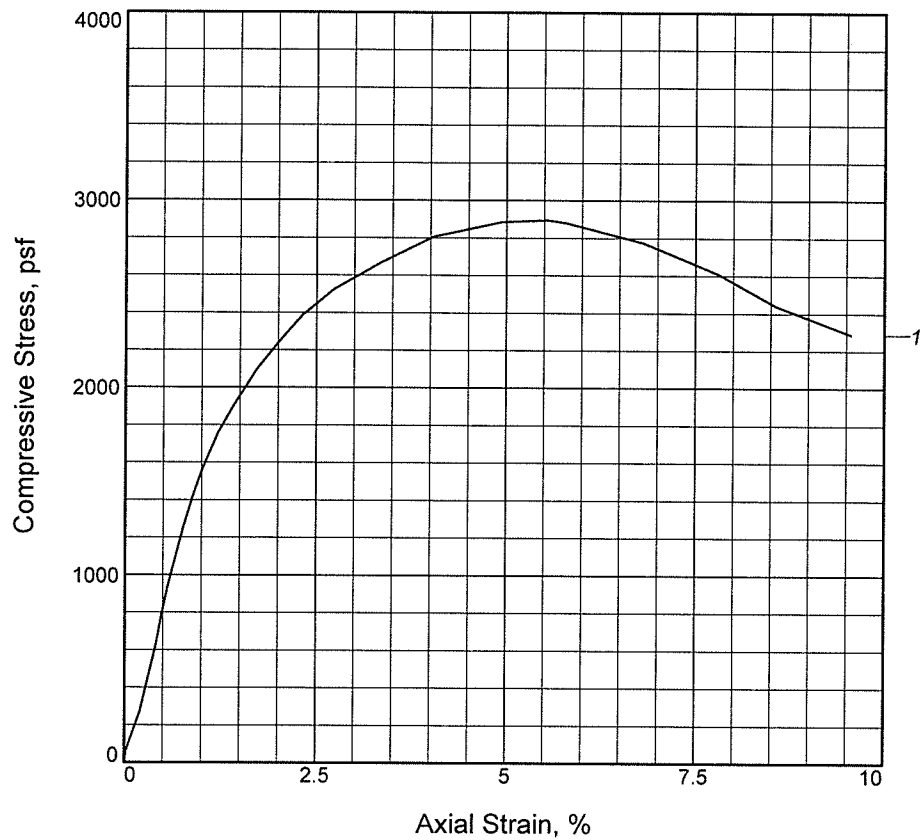
Sample Number: 2

Figure _____



Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2896			
Undrained shear strength, psf	1448			
Failure strain, %	5.5			
Strain rate, in./min.	0.050			
Water content, %	29.9			
Wet density, pcf	120.7			
Dry density, pcf	92.9			
Saturation, %	98.3			
Void ratio	0.8280			
Specimen diameter, in.	2.86			
Specimen height, in.	5.63			
Height/diameter ratio	1.97			

Description: Fat clay with weathered sandstone, very stiff, yellowish brown, moist

LL = **PL =** **PI =** **Assumed GS= 2.72** **Type: ST**

Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-11 **Depth:** 3

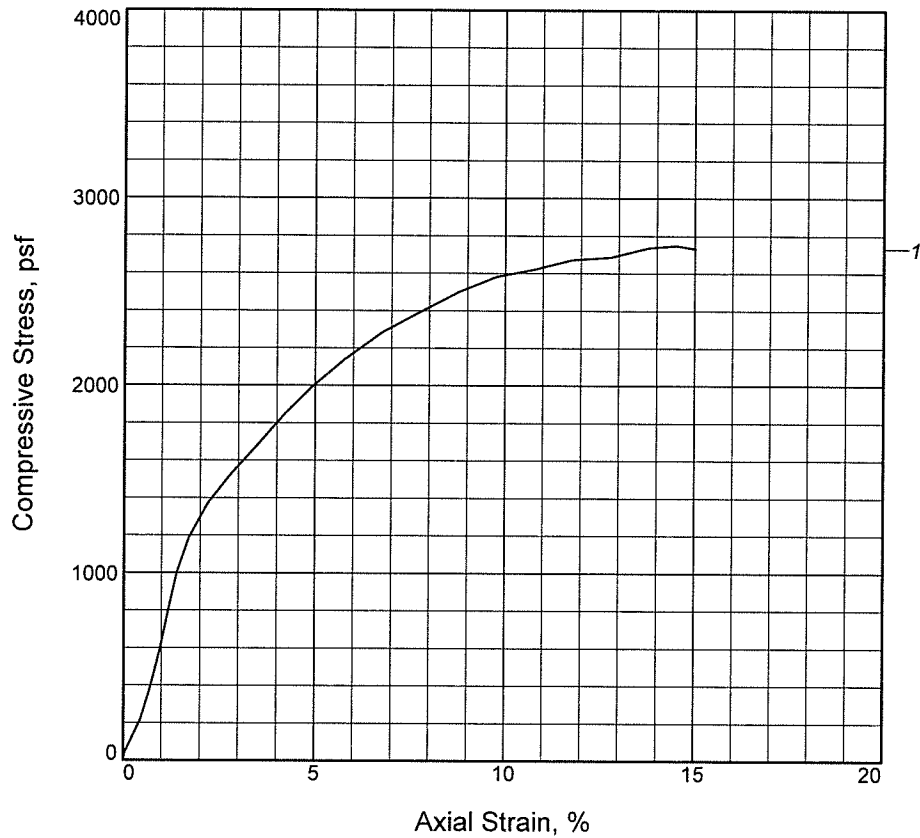
Sample Number: 2



Figure _____

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2748			
Undrained shear strength, psf	1374			
Failure strain, %	14.5			
Strain rate, in./min.	0.050			
Water content, %	27.5			
Wet density, pcf	119.8			
Dry density, pcf	94.0			
Saturation, %	92.6			
Void ratio	0.8066			
Specimen diameter, in.	2.82			
Specimen height, in.	5.58			
Height/diameter ratio	1.98			

Description: Fat clay with weathered sandstone, very stiff, yellow & reddish brown, moist

LL = **PL =** **PI =** **Assumed GS= 2.72** **Type: ST**

Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-13 **Depth:** 3

Sample Number: 2

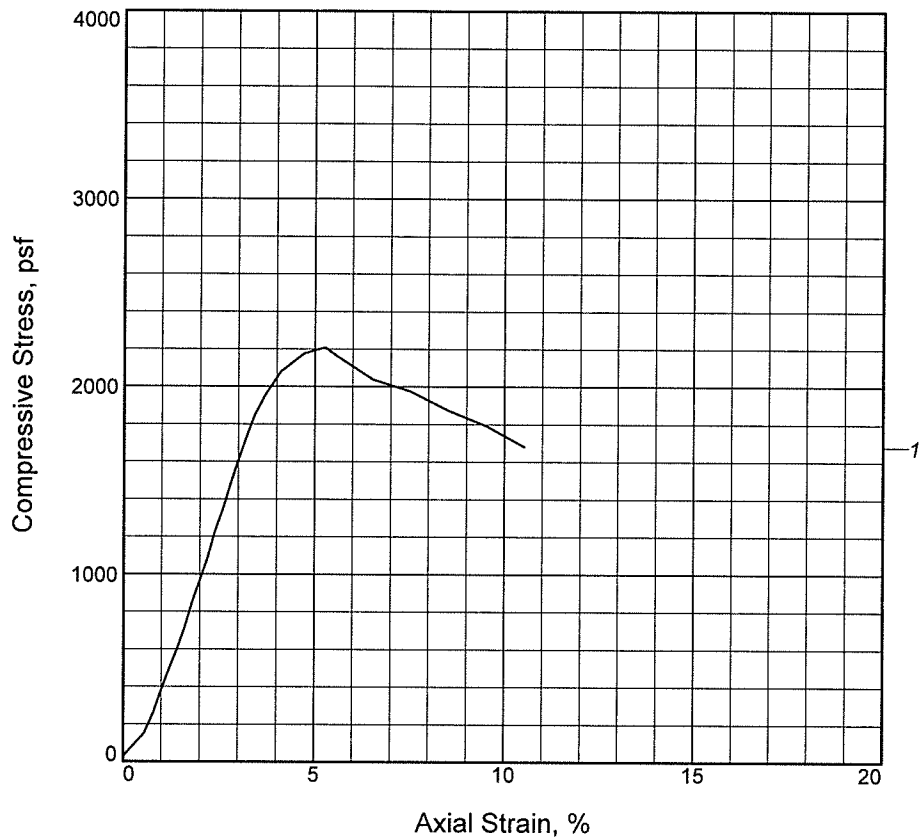


Figure _____

Tested By: TMA

Checked By: OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2208			
Undrained shear strength, psf	1104			
Failure strain, %	5.3			
Strain rate, in./min.	0.050			
Water content, %	17.0			
Wet density, pcf	114.2			
Dry density, pcf	97.6			
Saturation, %	62.4			
Void ratio	0.7390			
Specimen diameter, in.	2.82			
Specimen height, in.	5.58			
Height/diameter ratio	1.98			

Description: Fill, clayey gravel, trace moist, stiff, dark gray, moist

LL = **PL =** **PI =** **Assumed GS= 2.72** **Type: ST**

Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-16 **Depth:** 3

Sample Number: 2

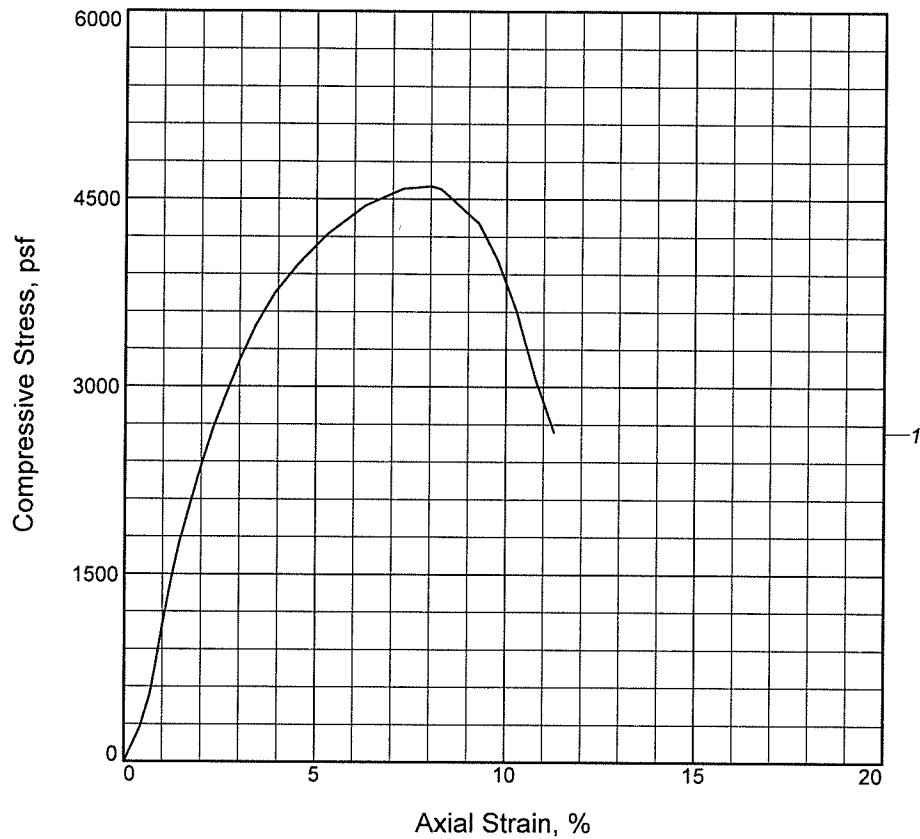
Figure _____

KTI

Tested By: TMA

Checked By: OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	4603			
Undrained shear strength, psf	2301			
Failure strain, %	8.0			
Strain rate, in./min.	0.050			
Water content, %	28.4			
Wet density, pcf	118.9			
Dry density, pcf	92.6			
Saturation, %	92.7			
Void ratio	0.8333			
Specimen diameter, in.	2.82			
Specimen height, in.	5.66			
Height/diameter ratio	2.01			

Description: Fat clay, stiff, olive gray, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST
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Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-17 **Depth:** 3

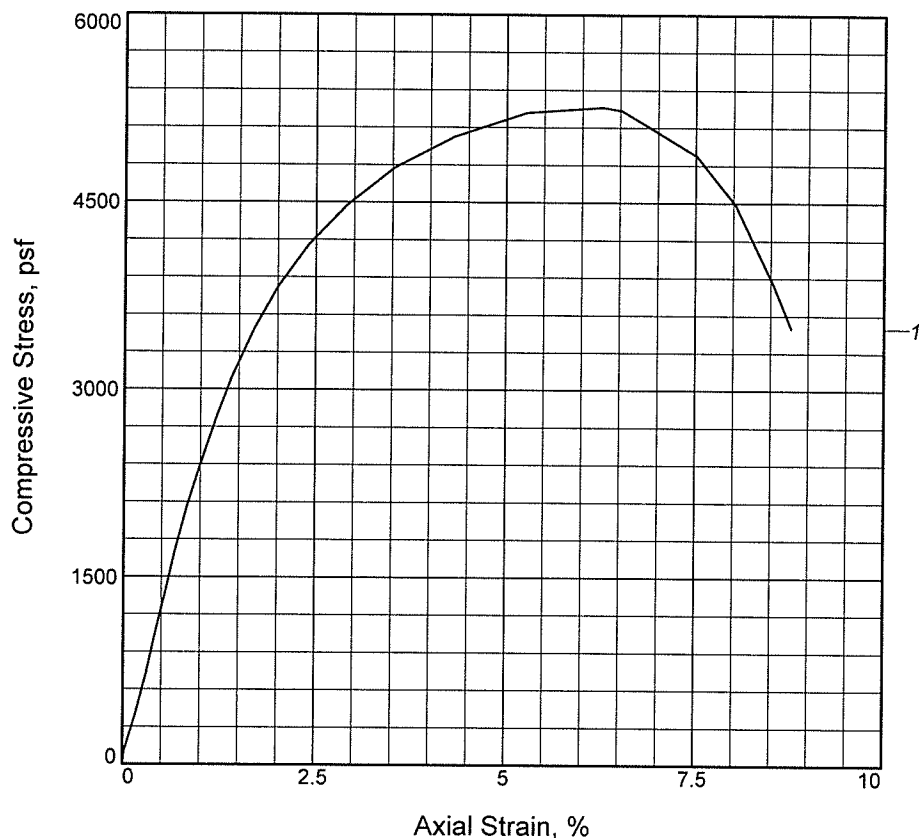
Sample Number: 1

Figure _____



Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	5261			
Undrained shear strength, psf	2630			
Failure strain, %	6.3			
Strain rate, in./min.	0.050			
Water content, %	29.2			
Wet density, pcf	116.8			
Dry density, pcf	90.4			
Saturation, %	90.5			
Void ratio	0.8775			
Specimen diameter, in.	2.82			
Specimen height, in.	5.62			
Height/diameter ratio	1.99			

Description: Fill, lean to fat clay with organics, stiff, brown & dark gray, moist

LL = 55

PL = 22

PI = 33

Assumed GS= 2.72

Type: ST

Project No.: 220057G

Date Sampled: 4/21/20

Remarks:

Client: John Knox Village

Project: JKV-Meadows Phase II and III

Source of Sample: B-18

Depth: 1

Sample Number: 1

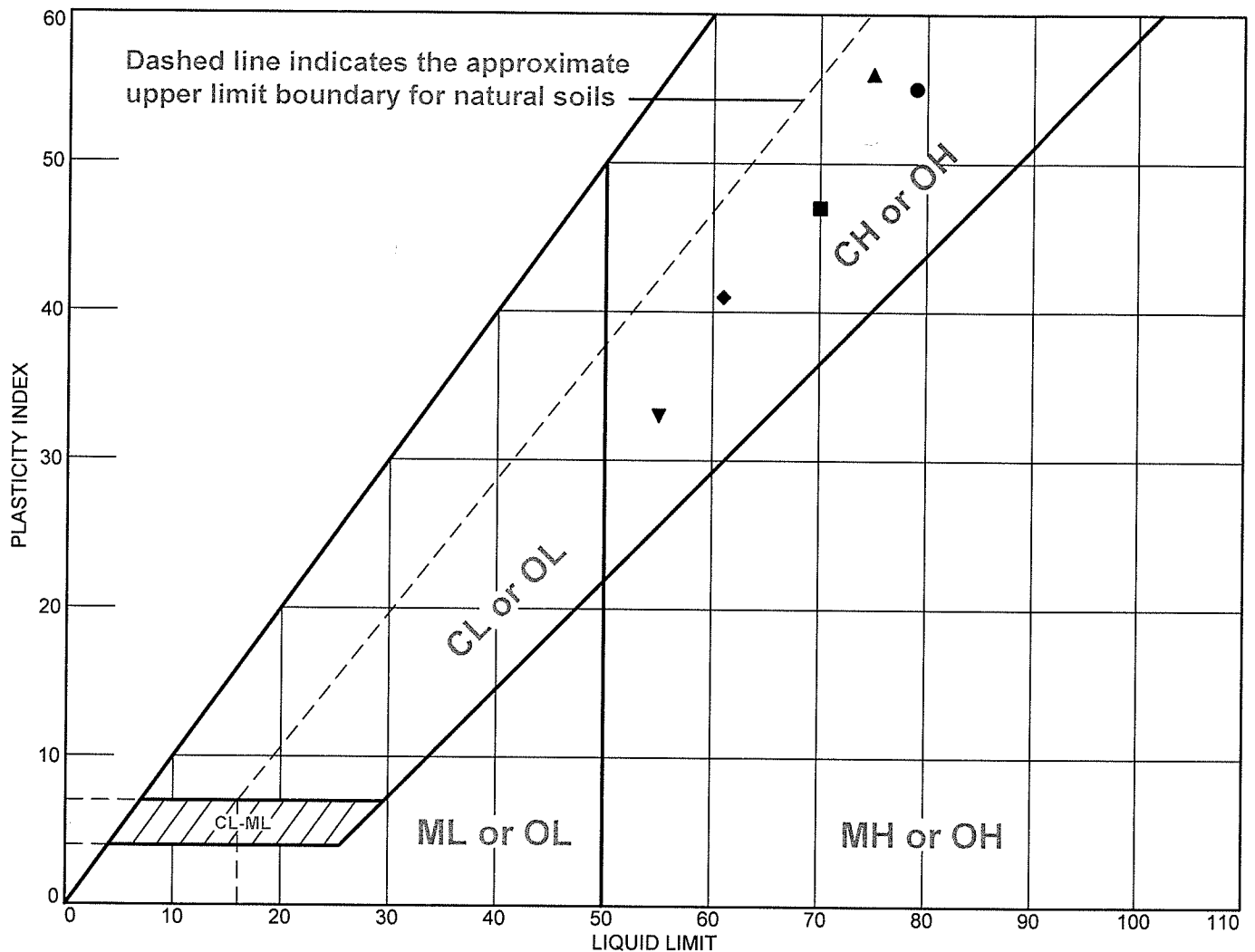
Figure _____

KTI

Tested By: TMA

Checked By: OJK

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Fill, clay with gravel, stiff, grayish brown, moist	79	24	55			CH
■	Fill, lean to fat clay, trace organics, stiff, dark brown, moist	70	23	47			CH
▲	Lean to fat clay, very stiff, grayish brown, moist	75	19	56			CH
◆	Fill, lean to fat clay with organics, very stiff, gray, moist	61	20	41			CH
▼	Fill, lean to fat clay with organics, stiff, brown & dark gray, moist	55	22	33			CH

Project No. 220057G Client: John Knox Village

Project: JKV-Meadows Phase II and III

● Source of Sample: B-1 Depth: 1 Sample Number: 1
 ■ Source of Sample: B-5 Depth: 1 Sample Number: 1
 ▲ Source of Sample: B-9 Depth: 1 Sample Number: 1
 ◆ Source of Sample: B-13 Depth: 1 Sample Number: 1
 ▼ Source of Sample: B-18 Depth: 1 Sample Number: 1

KTI

Remarks:

Figure

GLOSSARY OF GEOTECHNICAL TERMS

ALLUVIUM	Sediments deposited by streams, including riverbeds and floodplains.
ARGILLACEOUS	Rocks composed of or having a notable portion of fine silt and/or clay in their composition.
ATTERBERG LIMITS	Water contents, in percentage of dry weight of soil, that correspond to the boundaries between the states of consistency, i.e. the boundary between the liquid and plastic states (liquid limit) and the boundary between the plastic and solid states (plastic limit).
BEDROCK-IN-PLACE	Continuous rock mass which essentially has not moved from its original depositional position.
CALCAREOUS	Containing calcium carbonate determined by effervescence when tested with dilute hydrochloric acid.
CHANNEL SANDSTONE	Sandstone that has been deposited in a streambed or other channel eroded into the underlying beds.
COLLUVIAL	Rock debris of various sizes loose from in-place bedrock mass, often shifted down gradient in conjunction with soil.
CROSS-BEDDING	Stratification which is inclined to the original horizontal surface upon which the sediment accumulated.
FISSILE BEDDING	Term applied to bedding which consists of laminae less than 2 millimeters in thickness.
FORMATION	A distinctive body of rock that serves as a convenient unit for study and mapping.
FOSSIL DETRITUS	The accumulation of broken, fragmented fossil debris.
FOSSILIFEROUS	Containing organic remains.
GLACIAL ERRATIC	A transported rock fragment different from the bedrock on which it lies, either free or as part of a sediment.
GLACIAL TILL	Nonsorted, nonstratified sediment carried or deposited by a glacier.
GLACIOFLUVIAL	Primarily deposited by streams from glaciers.
GROUP	A lithostratigraphic unit consisting of two or more formations.
JOINT	A fracture in a rock along which no appreciable displacement has occurred.
LIMESTONE	A sedimentary rock composed mostly of calcium carbonate (CaCO_3).

LOESS	A homogenous, nonstratified, unindurated deposit consisting predominantly of silt, with subordinate amounts of very fine sand and/or clay.
MICA	A mineral group, consisting of phyllosilicates, with sheetlike structures.
MEMBER	A specially developed part of a varied formation is called a member, if it has considerable geographic extent.
NODULE	A small, irregular, knobby, or rounded rock that is generally harder than the surrounding rock.
PERMEABILITY	The capacity of a material to transmit a fluid.
RECOVERY	The percentage of bedrock core recovered from a core run length.
RELIEF	The difference in elevation between the high and low points of a land surface.
RESIDUAL SOIL	Soil formed in place by the disintegration and decomposition of rocks and the consequent weathering of the mineral materials.
ROCK QUALITY DESIGNATION (RQD)	Refers to percentage of core sample recovered in unbroken lengths of 4 inches or more.
SANDSTONE	Sedimentary rock composed mostly of sand sized particles, usually cemented by calcite, silica, or iron oxide.
SERIES	A time-stratigraphic unit ranked next below a system.
SHALE	A fine-grained plastic sedimentary rock formed by consolidation of clay and mud.
STRATIGRAPHY	Branch of geology that treats the formation, compositions, sequence, and correlation of the stratified rocks as parts of the earth's crust.
SYSTEM	Designates rocks formed during a fundamental chronological unit, a period.
UNCONFORMITY	A surface of erosion or nondeposition, usually the former, which separates younger strata from older rocks.
WEATHERING	The physical and chemical disintegration and decomposition of rocks and minerals.

General Notes

Laboratory Test Symbols	
Symbol	Definition
LL	Liquid Limit (ASTM D4318)
PL	Plastic Limit (ASTM D4318)
PI	Plasticity Index (LL minus PL)
Qu	Unconfined Compressive Strength, Pounds per Square Foot (psf)
Qp	Pocket Penetrometer Reading, Tons per Square Foot (TSF)
RQD	Rock Quality Designation % (Sum of rock core pieces >4 inches/length of core run)

Common Soil Classification Symbols

Clay		Silt	
Symbol	Soil Type	Symbol	Soil Type
CL	Low plasticity clay	ML	Low plasticity silt
CL-ML	Low plasticity clay and silt	MH	High plasticity silt
CL/CH	Medium plasticity clay		
CH	High plasticity clay		

Sand		Gravel	
Symbol	Soil Type	Symbol	Soil Type
SW	Well graded sand	GW	Well graded gravel
SP	Poorly graded sand	GP	Poorly graded gravel
SM	Silty sand	GM	Silty gravel
SC	Clayey sand	GC	Clayey gravel

Descriptive Terminology

Cohesionless Soils

Relative Density Term	"N" Value
Very Loose	0 - 4
Loose	5 - 9
Medium Dense	10 - 29
Dense	30 - 49
Very Dense	50 or more

Cohesive Soils

Consistency Term	"N" Value
Very soft	0 - 2
Soft	3 - 4
Medium	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	> 30

Relative Proportions and Sizes

Term	Range
Trace	< 5%
A Little	5 - 15%
Some	15 - 30%
With	30 - 50%

Material	Size
Boulder	> 12"
Cobble	3" - 12"
Gravel	4.75 - 76.2 mm
Sand	0.075 - 4.75 mm
Silt and Clay	< 0.075 mm