

## **Project Manual for**

Clemson University  
**Bryan Mall High Rises Renovation**

## **Mannings Hall – GMP 3**

Clemson, South Carolina

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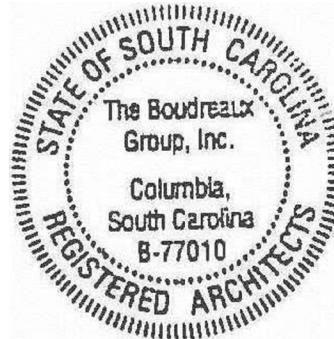
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## **CONSTRUCTION DOCUMENTS**

### **VOLUME 2 OF 2**

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## **TABLE OF CONTENTS**

### **CLEMSON UNIVERSITY - BRYAN MALL HIGH RISES RENOVATION**

### **MANNING HALL – GMP 8 CONSTRUCTION DOCUMENTS**

### **VOLUME 1 OF 2**

#### **DIVISION 0 - PROCUREMENT**

00 10 10	INDEX OF DRAWINGS – GMP 8
00 10 70	SPECIAL CONDITIONS – GMP 8
	ATTACHMENT 1 - DWG FILE REQ – GMP 8
	ATTACHMENT 2 - BRYAN MALL ADDITIONS - GEOTECH REPORT – GMP 3
	ATTACHMENT 3 - BRYAN MALL SHALLOW FOUNDATION LETTER – GMP 3

#### **DIVISION 1 - GENERAL REQUIREMENTS**

01 10 00	SUMMARY – GMP 8
01 22 00	UNIT PRICES – GMP 8
01 25 00	SUBSTITUTION PROCEDURES – GMP 8
01 26 00	CONTRACT MODIFICATION PROCEDURES – GMP 8
01 29 00	PAYMENT PROCEDURES – GMP 8
01 31 00	PROJECT MANAGEMENT AND COORDINATION – GMP 8
01 32 00	CONSTRUCTION PROGRESS DOCUMENTATION – GMP 8
01 32 23	SURVEY & LAYOUT DATA – GMP 8
01 32 33	PHOTOGRAPHIC AND VIDEO DOCUMENTATION – GMP 3
01 33 00	SUBMITTAL PROCEDURE – GMP 8
01 40 00	QUALITY REQUIREMENTS – GMP 8
01 41 00	SPECIAL INSPECTIONS AND TESTING – GMP 8
01 42 00	REFERENCES – GMP 8
01 50 00	TEMPORARY FACILITIES AND CONTROLS – GMP 8
01 57 13	TEMPORARY EROSION & SEDIMENT CONTROL – GMP 8
01 60 00	PRODUCT REQUIREMENTS – GMP 8
01 73 00	EXECUTION – GMP 8
01 73 29	CUTTING AND PATCHING – GMP 8
01 74 19	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL – GMP 8
01 77 00	CLOSEOUT PROCEDURES – GMP 8
01 78 23	OPERATIONS AND MAINTENANCE DATA – GMP 8
01 78 39	PROJECT RECORD DOCUMENTS – GMP 8
01 79 00	DEMONSTRATION AND TRAINING – GMP 8
01 81 13.54	SUSTAINABLE DESIGN REQUIREMENTS - GREEN GLOBES 2021 – GMP 8
01 91 13	GENERAL COMMISSIONING REQUIREMENTS – <b>FROM GMP 3</b>

**DIVISION 2 - EXISTING CONDITIONS**

02 41 19	SELECTIVE DEMOLITION – GMP 8
02 82 33	SM&E – REMOVAL AND DISPOSAL OF ASBESTOS CONTAINING MATERIALS - GMP 8

**DIVISION 3 - CONCRETE**

03 30 00	CAST -IN-PLACE CONCRETE – GMP 8
03 53 00	CONCRETE TOPPING – GMP 8
03 54 16	HYDRAULIC CEMENT UNDERLAYMENT – GMP 8

**DIVISION 4 - MASONRY**

04 20 00	UNIT MASONRY – GMP 8
----------	----------------------

**DIVISION 5 - METALS**

05 12 00	STRUCTURAL STEEL FRAMING – GMP 8
05 31 00	STEEL DECKING – GMP 2
05 40 00	COLD-FORMED METAL FRAMING – GMP 8
05 50 00	METAL FABRICATIONS – GMP 8
05 51 13	METAL PAN STAIRS – GMP 8
05 51 19	METAL GRATING STAIRS – GMP 8
05 52 13	PIPE AND TUBE RAILINGS – GMP 8

**DIVISION 6 - WOOD, PLASICS, AND COMPOSITES**

06 10 53	MISCELLANEOUS ROUGH CARPENTRY GMP 8
06 16 00	SHEATHING – GMP 8
06 41 16	PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS – GMP 8
06 83 16	FIBERGLASS-REINFORCED PANELING (FRP) – GMP 8

**DIVISION 7 - THERMAL & MOISTURE PROTECTION**

07 01 50.19	PREPARATION FOR REROOFING – GMP 8
07 13 26	SELF ADHERING SHEET WATERPROOFING – GMP 8
07 18 00	PEDESTRIAN TRAFFIC COATINGS – GMP 8
07 21 00	THERMAL INSULATION – GMP 8
07 24 15	POLYMER-BASED DIRECT APPLIED EXTERIOR FINISH SYSTEM – GMP 8
07 27 26	FLUID-APPLIED MEMBRANE AIR BARRIERS – GMP 8
07 42 13.19	INSULATED METAL WALL PANELS – GMP 8
07 42 13.23	METAL COMPOSITE MATERIAL WALL PANELS – GMP 8
07 42 93	SOFFIT PANELS – GMP 8
07 54 23	THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING – GMP 8
07 62 00	SHEET METAL FLASHING AND TRIM – GMP 8
07 72 00	ROOF ACCESSORIES – GMP 8

07 81 00	APPLIED FIREPROOFING – GMP 8
07 81 23	INTUMESCENT FIRE PROTECTION – GMP 8
07 84 13	PENETRATION FIRESTOPPING – GMP 8
07 84 13A	PENETRATION FIRESTOPPING SCHEDULE – GMP 8
07 84 43	JOINT FIRESTOPPING – GMP 8
07 84 46	FIRE-RESISTIVE JOINT SYSTEMS – GMP 8
07 92 00	JOINT SEALANTS – GMP 8
07 95 13.13	INTERIOR EXPANSION JOINT COVER ASSEMBLIES – GMP 8
07 95 13.16	EXTERIOR EXPANSION JOING COVER ASSEMBLIES – GMP 8

## **DIVISION 8 - OPENINGS**

08 11 13	HOLLOW METAL DOORS AND FRAMES – GMP 8
08 14 16	FLUSH WOOD DOORS – GMP 8
08 31 13	ACCESS DOORS AND FRAMES – GMP 8
08 41 13	ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS- GMP 1 – <b>Rev GMP 8</b>
08 44 13	GLAZED ALUMINUM CURTAIN WALLS – GMP 1 – <b>Rev GMP 8</b>
08 71 00	DOOR HARDWARE – GMP 8
	ATTACHMENT – ELECTRONIC DOOR HARDWARE SCHEDULE – GMP 8
08 80 00	GLAZING – GMP 1 – <b>Rev GMP 8</b>
08 83 00	MIRRORS – GMP 8
08 88 13	FIRE-PROTECTIVE GLAZING- GMP 8
08 91 19	FIXED LOUVERS – GMP 8

## **DIVISION 9 - FINISHES**

09 21 16.23	GYPSUM BOARD SHAFT WALL ASSEMBLIES – GMP 8
09 22 16	NON-STRUCTURAL METAL FRAMING – GMP 8
09 29 00	GYPSUM BOARD – GMP 8
09 30 13	CERAMIC TILING – GMP 8
09 51 13	ACOUSTICAL PANEL CEILINGS – GMP 8
09 65 13	RESILIENT BASE AND ACCESSORIES – GMP 8
09 65 19	RESILIENT TILE FLOORING – GMP 8
09 65 36	STATIC-CONTROL RESILIENT FLOORING – GMP 8
09 68 13	TILE CARPETING – GMP 8
09 91 13	EXTERIOR PAINTING – GMP 8
09 91 23	INTERIOR PAINTING – GMP 8
09 97 23	PENETRATING CONCRETE SEALER – GMP 8



## **VOLUME 2 OF 2**

### **DIVISION 10 - SPECIALTIES**

10 14 23.16	ROOM-IDENTIFICATION PANEL SIGNAGE – GMP 8
10 26 00	WALL SURFACE PROTECTION SYSTEMS – GMP 3
10 28 00	TOILET, BATH, AND LAUNDRY ACCESSORIES – GMP 8
10 44 13	FIRE PROTECTION CABINETS – GMP 8
10 44 16	FIRE EXTINGUISHERS – GMP 8
10 73 16	METAL CANOPIES – GMP 8

### **DIVISION 11 - EQUIPMENT**

11 30 13	RESIDENTIAL APPLIANCES – GMP 8
----------	--------------------------------

### **DIVISION 12 - FURNISHINGS**

12 21 13	HORIZONTAL LOUVER BLINDS – GMP 8
12 24 13	ROLLER WINDOW SHADES – GMP 8
12 36 61.16	SOLID SURFACING COUNTERTOPS – GMP 8
12 36 61.19	QUARTZ AGGLOMERATE COUNTERTOPS – GMP 8

### **DIVISION 13 - SPECIAL CONSTRUCTION**

### **DIVISION 14 - CONVEYING EQUIPMENT**

14 21 00	ELECTRIC TRACTION ELEVATORS GMP 1
----------	-----------------------------------

### **DIVISION 21 - FIRE SUPPRESSION**

21 00 10	GENERAL PROVISIONS – FIRE PROTECTION – GMP 8
21 05 00	FIRE PROTECTION – GMP 8

### **DIVISION 22 - PLUMBING**

22 00 10	GENERAL PROVISIONS – PLUMBING – GMP 8
22 05 00	PLUMBING – GMP 8
22 07 00	PLUMBING INSULATION – GMP 8
22 08 00	COMMISSIONING OF SERVICE WATER HEATING SYSTEMS – <i>from GMP 3</i>

### **DIVISION 23 - HEATING, VENTILATION & AIR CONDITIONING**

23 00 10	GENERAL PROVISIONS – HVAC – GMP 8
23 05 00	HEATING, VENTILATION, AND AIR CONDITIONING – GMP 8
23 05 01	AIR HANDLING UNIT – GMP 8

23 05 02	DEDICATED OUTDOOR AIR UNIT – GMP 8
23 05 48	VIBRATION ISOLATION AND SEISMIC/WIND RESTRAINT – GMP 8
23 07 00	HVAC INSULATION – GMP 8
23 08 00	COMMISSIONING OF HVAC – <i>from GMP 3</i>
23 09 00	CENTRAL CONTROL AND MONITORING SYSTEM – GMP 8

## **DIVISION 26 - ELECTRICAL**

26 05 00	COMMON WORK RESULTS FOR ELECTRICAL – GMP 8
26 05 13	MEDIUM VOLTAGE CABLES – GMP 8
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS – GMP 8
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS – GMP 8
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS – GMP 8
26 05 34	FLOOR BOXES FOR ELECTRICAL SYSTEMS – GMP 8
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS – GMP 8
26 05 74	SHORT CIRCUIT, OVERCURRENT PROTECTION, ARC FLASH HAZARD ANALYSIS – GMP 2
26 05 83	EQUIPMENT WIRING CONNECTIONS – GMP 8
26 08 00	COMMISSIONING OF LIGHTING CONTROL SYSTEMS – <i>from GMP 3</i>
26 09 23	LIGHTING CONTROL DEVICES – GMP 8
26 24 13	LOW VOLTAGE SWITCHBOARDS – GMP 1
26 24 16	PANELBOARDS – GMP 8
26 24 17	COORDINATION PANELBOARDS- FUSIBLE – GMP 8
26 25 00	ENCLOSED BUS ASSEMBLIES – GMP 8
26 27 26	WIRING DEVICES – GMP 8
26 28 13	FUSES – GMP 8
26 28 19	ENCLOSED SWITCHES – GMP 8
26 28 26	ENCLOSED TRANSFER SWITCHES – GMP 1
26 32 13	ENGINE GENERATORS - GMP 1
26 41 00	FACILITY LIGHTNING PROTECTION – GMP 8
26 43 00	SURGE PROTECTIVE DEVICES – GMP 8
26 51 00	INTERIOR LIGHTING – GMP
26 52 00	EMERGENCY LIGHTING – GMP 8
26 56 00	EXTERIOR LIGHTING – GMP 8

## **DIVISION 27 - COMMUNICATIONS**

27 05 00	COMMON WORK RESULTS FOR COMMUNICATIONS – GMP 8
27 05 26	GROUNDING AND BONDING FOR COMMUNICATIONS – GMP 8
27 05 29	HANGER AND SUPPORTS FOR COMMUNICATIONS SYSTEMS – GMP 8
27 05 33	CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS – GMP 8
27 05 36	CABLE TRAYS FOR COMMUNICATIONS SYSTEMS – GMP 8
27 11 00	COMMUNICATIONS EQUIPMENT ROOM FITTINGS – GMP 8
27 13 00	COMMUNICATIONS BACKBOND CABLING – GMP 8
27 15 00	COMMUNICATIONS HORIZONTAL CABLING – GMP 8
27 32 00	VOICE COMMUNICATIONS TELEPHONE SETS – GMP 8
27 41 00	AUDIO-VIDEO SYSTEMS -GMP 8

27 41 16	INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENTS – GMP 8
27 83 06	RADIO ENHANCEMENT SYSTEM – GMP 8

#### **DIVISION 28 - ELECTRONIC SAFETY AND SECURITY**

28 05 00	COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY – GMP 8
28 05 13	CONDUCTORS AND CABLES OF ELECTRONIC SAFETY AND SECURITY – GMP 8
28 13 00	ACCESS CONTROL SYSTEM – GMP 8
28 23 00	VIDEO SURVEILLANCE SYSTEM – GMP 8
28 31 00	FIRE DETECTION AND ALARM – GMP 8

#### **DIVISION 31 - EARTHWORK**

31 10 00	SITE CLEARING – GMP 8
31 20 00	EARTH MOVING – GMP 8
31 23 17	TRENCHING AND EXCAVATION – GMP 8
31 31 16	TERMITE CONTROL – GMP 8

#### **DIVISION 32 - EXTERIOR IMPROVEMENTS**

32 13 73	CONCRETE PAVING JOINT SEALANTS – GMP 8
32 14 00	UNIT PAVING – GMP 8
32 16 00	CONCRETE CURBS, GUTTERS, SIDEWALKS AND DRIVEWAYS – GMP 8
32 31 13	CHAIN LINK FENCES AND GATES – GMP 8
32 49 10	MISCELLANEOUS SITE STONework – GMP 8
32 84 00	LANDSCAPE IRRIGATION – GMP 8
32 91 00	PLANTING SOIL SYSTEM – GMP 8
32 91 15	SOIL PREPARATION – GMP 8
32 91 50	LANDSCAPE UNDERDRAIN – GMP 8
32 92 00	TURF AND GRASSES – GMP 8
32 93 00	PLANTS – GMP 8
32 94 50	WELDED WIRE PANEL PLANT SUPPORT SYSTEM – GMP 8

#### **DIVISION 33 - UTILITIES**

33 10 00	WATER UTILITIES – GMP 8
33 30 00	SANITARY SEWERAGE – GMP 8
33 40 00	STORMWATER UTILITIES – GMP 8

**END OF TABLE OF CONTENTS**

## SECTION 10 14 23.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

### 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section includes room-identification signs.

#### 1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

#### 1.4 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Product Data, Low Emitting Materials: Submit product data for interior adhesives and sealants, indicating VOC content limits and emissions and description of testing or certification for site installed interior materials and products.
  - 2. Laboratory Test Reports: Submit test reports for interior adhesives and sealants, indicating compliance with requirements for low emitting materials.
  - 3. Product Data, Regional Materials: Submit for materials manufactured within 100 miles (160 km) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.
  - 4. Environmental Impact Disclosure and Optimization: Provide the following for each product:
    - a. Type III, product-specific Environmental Product Declaration.

- b. Industry-wide, generic Environmental Product Declaration.
  - 5. Health Impact Disclosure and Optimization: Provide one of the following for each product:
    - a. Compliance Pathway 1: Health Product Declaration or Declare label.
    - b. Compliance Pathway 2: One of the following product health declarations by the following:
      - 1) LBC Red List Free.
      - 2) C2C Cradle-to-Cradle.
      - 3) C2C Material Health Certificate.
  - C. Shop Drawings: For room-identification signs.
    - 1. Include fabrication and installation details and attachments to other work.
    - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
    - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
  - D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
    - 1. Room-Identification Signs: Full-size Sample.
    - 2. Variable Component Materials: Full-size Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
    - 3. Exposed Accessories: Full-size Sample of each accessory type.
    - 4. Full-size Samples, if approved, will be returned to Contractor for use in Project.
  - E. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
  - B. Sample Warranty: For special warranty.
- 1.7 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For signs to include in maintenance manuals.
- 1.8 QUALITY ASSURANCE
- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

## 1.9 FIELD CONDITIONS

- A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Deterioration of embedded graphic image.
    - c. Separation or delamination of sheet materials and components.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

### 2.2 ROOM-IDENTIFICATION SIGNS

- A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
  - 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. ACE Sign Systems, Inc.
    - b. APCO Graphics, Inc.
    - c. ASI Sign Systems, Inc.
    - d. Best Sign Systems, Inc.
    - e. InPro Corporation (IPC).
  - 2. Laminated-Sheet Sign: Photopolymer or sandblasted polymer face sheet with raised graphics laminated over subsurface graphics to acrylic backing sheet to produce composite sheet.
    - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign.
    - b. Subsurface Graphics: Reverse halftone or dot-screen image.

- c. Color(s): Match Architect's sample.
- 3. Sign-Panel Perimeter: Finish edges smooth.
  - a. Edge Condition: Square cut.
  - b. Corner Condition in Elevation: Square unless otherwise indicated..
- 4. Mounting: Surface mounted with two-face tape.
- 5. Text and Typeface: Accessible raised characters and Braille, typeface as indicated, or if not indicated, as selected by Architect from manufacturer's full range and variable content as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color.

## 2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

## 2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
  - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
  - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
  - 4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are 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 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
  - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Accessibility: Install signs in locations on walls as indicated on Drawings and according to the accessibility standard.
- C. Mounting Methods:
  - 1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

### 3.2 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 23.16



## SECTION 10 26 00 - WALL SURFACE PROTECTION SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Flush-Mounted, Plastic or Rigid Vinyl Cover Corner Guards

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
- B. Samples for Initial Selection: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type of exposed plastic material.
- B. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall protection product to include in maintenance manuals.
  - 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

## 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. Corner-Guard Covers: Full-size plastic covers of maximum length equal to 2 percent of each type, color, and texture of cover installed.
  - 2. Mounting and Accessory Components: Amounts proportional to the quantities of extra materials. Package mounting and accessory components with each extra material.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
  - 1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
  - 2. Keep plastic materials out of direct sunlight.
  - 3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).
    - a. Store corner-guard covers in a vertical position.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall protection units that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
    - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall protection products from single source from single manufacturer.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. NFPA Class A fire rating.
  - 2. Flame-Spread Index: 25 or less.
  - 3. Smoke-Developed Index: 450 or less.
- B. Fire Rating of Fire Rated Expansion Joint Covers:
  - 1. Provide UL Classified assemblies meeting the requirements of ANSI/UL 2079 "Test of Fire Resistance of Building Joint System" to maintain the rating of wall assemblies.
- C. Self-Extinguishing:
  - 1. Provide corner guards with a CC1 classification, as tested in accordance with the procedures specified in ASTM D-635-74, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position, as referenced in UBC 52-4-1988.
- D. Chemical and Stain Resistance:
  - 1. Provide corner guards that show resistance to stain when tested in accordance with applicable provisions of ASTM D-543.
- E. Sustainable:
  - 1. Low VOC's

## 2.3 CORNER GUARDS

- A. Surface-Mounted, Plastic or Rigid Vinyl Cover Corner Guards: Manufacturer's standard, PVC-free, assembly consisting of snap-on, resilient plastic or vinyl cover that is flush with adjacent wall surface, installed over retainer; including mounting hardware; fabricated with 90 degree turn to match wall condition:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide CS Acrovyn SSM-20 surface-mount or a comparable product by one of the following:
    - a. InPro Corp
    - b. Pawling Corporation.
    - c. Korogard Wall Protection Systems, Koroseal.
    - d. American Floor Mats.
    - e. IPC Door and Wall Protection Systems, Division of Inpro Corporation.
  - 2. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) wall thickness,
    - a. Profile: Nominal 2-inch- (51.2-mm-) long leg and 1/4-inch (6-mm) corner radius and 90 degree angle.

- b. Height: 4'-0" High.
  - c. Color and Texture: As indicated on Finish Schedule and as selected by Architect from manufacturer's full range for final selections and confirmation.
- 3. Continuous Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
  - 4. Retainer Clips: Manufacturer's standard impact-absorbing clips.

## 2.4 MATERIALS

### A. Plastic or Rigid Vinyl Materials:

- 1. Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- 2. Fungal and Bacterial Resistance: Provide plastic or rigid vinyl that does not support fungal or bacterial growth as tested in accordance with ASTM G-21 and ASTM G-22.
- 3. Color Consistency: Provide components matched in accordance with SAE J-1545 – (Delta E) with a color difference no greater than 1.0 units using CIE Lab, CIE CMC, CIE LCh, Hunter Lab or similar color space scale systems.
- 4. GREENGUARD Certified: Provide GREENGUARD Certified material. Profiles shall meet the requirements of GREENGUARD Certification Standards for Low-Emitting Products.

### B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or Class 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft.-lbf/in. (800 J/m) of notch when tested according to ASTM D 256, Test Method A.

### C. Rigid Vinyl: Provide rigid vinyl profile materials that have an Impact Strength of 30.2 ft.-lbs/inch of thickness as tested in accordance with procedures specified in ASTM D-256-90b, Impact Resistance of Plastics.

### D. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

## 2.5 FABRICATION

### A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

### B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

### C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

## 2.6 FINISHES

- A. Protect 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 wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine walls to which wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
- C. Maintain continuity of fire rated gypsum board behind corner guards and anchoring components of corner guards to maintain partition fire rating behind corner guards.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

### 3.3 INSTALLATION

- A. Installation Quality: Install protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Mounting Heights: Install wall protection in locations indicated on Drawings with the bottom edge starting at the top of the wall base.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
  - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
  - 2. Adjust caps as required to ensure tight seams.

### 3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.

END OF SECTION 10 26 00

## SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Public-use washroom accessories.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
  - 1. Construction details and dimensions.
  - 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
  - 3. Material and finish descriptions.
  - 4. Features that will be included for Project.
  - 5. Manufacturer's warranty.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same articles in Part 2, provide products of same manufacturer unless otherwise approved by Architect.

#### 1.5 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

## 1.6 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.
- C. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- D. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

### 2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Manufacturer: Subject to compliance with requirements, provide products indicated on drawings or comparable products by one of the following:
1. American Specialties Inc.
  2. Bobrick Washroom Equipment, Inc.
  3. Bradley Corporation.
  4. Georgia Pacific.
  5. Trubro.
  6. Brocar.

### 2.3 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.



## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

### 3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 10 28 00

## SECTION 104413 - FIRE EXTINGUISHER CABINETS

### 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. Non-Rated and One-Hour Rated Fire protection cabinets for the following:
    - a. Portable fire extinguishers.
- B. Related Sections:
  - 1. Division 10 Section "Fire Extinguishers."

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
  - 1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- B. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), 3mm thick, with Finish 1 (smooth or polished).

### 2.2 FIRE PROTECTION CABINET

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. JL Industries, Inc.
  - 2. Larsen's Manufacturing Company.
  - 3. Modern Metal Products; Div. of Technico.
  - 4. Potter Roemer; Div. of Smith Industries, Inc.
  - 5. Sampson Products, Inc.
- B. Cabinet Type: Suitable for fire extinguisher.
- C. Cabinet Construction: **Non-rated.** See B-A3.2 for detail of cabinet in 30 minute fire rated walls.
- D. Cabinet Material: Painted steel sheet.
- E. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
  - 1. Rolled-Edge Trim: 3-inch (76.5-mm) backbend depth
  - 2. **Note: 3-inch Cabinet Projection is required with most manufacturers in order for the FE Cabinet to fit in 3 5/8-inch steel stud wall and be deep enough for the Fire Extinguisher. 4-inches is the maximum projection allowed by code.**
- F. Cabinet Trim Material: Painted steel sheet.
- G. Door Material: Painted steel sheet.
- H. Door Style: Narrow vertical glazed lite in steel door panel with frame.
- I. Door Glazing: Clear tempered safety glass.
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
  - 1. Provide projecting lever handle with cam-action latch.
  - 2. Provide manufacturer's standard hinge permitting door to open 180 degrees.

K. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Door Lock: Cam lock/keyed cylinder that allows door to be opened during emergency by pulling sharply on door handle.
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
  - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
    - 1) Location: Applied to cabinet glazing.
    - 2) Application Process: Silk-screened.
    - 3) Lettering Color: Black.
    - 4) Orientation: Vertical.

L. Finishes:

1. Polyester Painted: Color to be selected by Architect from manufacturer's standard colors.

## 2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
  2. Provide factory-drilled mounting holes.
  3. Prepare doors and frames to receive locks.
  4. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
  2. Fabricate door frames of one-piece construction with edges flanged.
  3. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

## 2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire protection cabinets after assembly.
- D. 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.

## 2.5 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- B. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare recesses for semi-recessed fire protection cabinets as required by type and size of cabinet and trim style.

### 3.3 INSTALLATION

- A. General: Install fire protection cabinets in locations and at mounting heights indicated.
- B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
  - 1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semi-recessed fire protection cabinets.
  - 2. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

### 3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

## SECTION 104416 - FIRE EXTINGUISHERS

### 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 portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Sections:
  - 1. Division 10 Section "Fire Extinguisher Cabinets."

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
  - 1. Provide fire extinguishers approved, listed, and labeled by FMG.

#### 1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure of hydrostatic test according to NFPA 10.
    - b. Faulty operation of valves or release levers.

## PART 2 - PRODUCTS

### 2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
    - a. Amerex Corporation.
    - b. Ansul Incorporated; Tyco International Ltd.
    - c. Badger Fire Protection; a Kidde company.
    - d. Buckeye Fire Equipment Company.
    - e. Fire End & Croker Corporation.
    - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
    - g. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
    - h. Larsen's Manufacturing Company.
    - i. Moon-American.
    - j. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc.
    - k. Potter Roemer LLC.
    - l. Pyro-Chem; Tyco Safety Products.
  - 2. Valves: Manufacturer's standard
  - 3. Handles and Levers: Manufacturer's standard
  - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Regular Dry-Chemical Type in Steel Container: UL-rated 60-B:C, 10-lb (4.5-kg) nominal capacity, with sodium bicarbonate-based dry chemical in enameled-steel container.
  - 1. Provide at bracket locations in all Electrical Rooms and Mechanical Rooms where indicated on drawings.
- C. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 5-lb (2.3-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.



1. Provide at all fire extinguisher cabinets typical.
2. Provide at bracket locations in Staff Apartments.
3. Provide at fire extinguisher cabinets at community Kitchen areas.

## 2.2 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amerex Corporation.
    - b. Ansul Incorporated; Tyco International Ltd.
    - c. Badger Fire Protection; a Kidde company.
    - d. Buckeye Fire Equipment Company.
    - e. Fire End & Croker Corporation.
    - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
    - g. Larsen's Manufacturing Company.
    - h. Potter Roemer LLC.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
  1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
    - a. Orientation: Vertical.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
  1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
  1. Mounting Brackets: 48 inches (1372 mm) above finished floor to top of fire extinguisher.

- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

## SECTION 10 73 16 - METAL CANOPIES

### 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. Pre-fabricated custom canopies.
  - 2. Flashings at connection of canopy to building.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide metal canopy systems capable of withstanding applicable loads and thermal and structural movements indicated without failure. Failure includes the following:
  - 1. Deflection exceeding specified limits.
  - 2. Framing members transferring stresses, including those caused by thermal and structural movement.
  - 3. Noise or vibration created by thermal and structural movement and wind.
  - 4. Loosening or weakening of fasteners, attachments, and other components.
- B. Deflection Limits: As follows:
  - 1. Deflection of the entire length of framing members in any direction is limited to 1/180 of clear span or 3/4 inch, whichever is smaller, unless otherwise indicated.
- C. Structural Loads: Provide awning and canopy systems, including anchorage, capable of withstanding the effects of the following design loads when supporting full dead loads:
  - 1. Wind Loads: As indicated.
  - 2. Snow Loads: As indicated.
  - 3. Seismic Loads: As indicated.
- D. Structural Performance: Provide metal canopy systems, including anchorage, capable of withstanding test pressure indicated without material and deflection failures and permanent deformation of structural members exceeding 0.2 percent of span when tested according to ASTM E 330.
  - 1. Test Pressure: 150 percent of positive and negative wind-load design pressures.

2. Test Duration: As required by design wind velocity; fastest 1 mile of wind for relevant exposure category.
- E. Thermal Movement: Provide metal canopy systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling and other detrimental effects.
  1. Temperature Change (Range): 120 deg F, ambient; 180 deg F material surfaces.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of metal canopies and accessories indicated.
- B. Shop Drawings: Show layouts of metal canopy, including plans, elevations, sections, details, and attachment to other work.
  1. Accessories: Include details of the following items:
    - a. Flashing and trim.
    - b. Gutters.
    - c. Downspouts.
    - d. Scuppers.
  2. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples For Verification: For each type of exposed finish required, prepared on samples of size indicated below:
  1. Metal Canopy Panel: 12 inches long by actual panel width. Include fasteners, closures, and other metal canopy accessories.
  2. Flashing and Trim: Nominal 12 inches long. Include fasteners and other exposed accessories.
- D. Qualification Data: For Installer.
- E. Maintenance Data: For metal canopy to include in maintenance manual.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
  1. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed

for installations of awnings and canopies that are similar to those indicated for this Project in material, design, and extent.

- C. Source Limitations: Obtain each type of canopy system, including framing, hardware, and accessories from one source and by a single manufacturer.
- D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of canopy systems. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, one another, and adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, or in-service performance.
  - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- E. Preinstallation Conference: Conduct conference at Project site to review methods and procedures related to canopy systems, including, but not limited to, the following:
  - 1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
  - 2. Review structural load limitations.
  - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review required testing procedures.
  - 5. Review weather and forecasted weather conditions and procedures for unfavorable conditions.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal canopy panels, and other manufactured items so as not to be damaged or deformed. Package metal canopy panels for protection during transportation and handling.
- B. Unload, store, and erect metal canopy panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack canopy roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal canopy panels to ensure dryness. Do not store metal canopy panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect strippable protective covering on metal canopy panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

#### 1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal canopy to be performed according to manufacturer's written instructions and warranty requirements.
- B. Field Measurements: Where canopy systems are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

## 1.8 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of canopy systems that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
  - 1. Structural failures.
  - 2. Failure of systems to meet performance requirements.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 4. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Custom Canopies:
  - 1. Basis of Design: Subject to compliance with requirements, provide products as manufactured by MASA Architectural Canopies, Inc. or a comparable product by one of the following:
    - a. Dittmer.
    - b. Mapes Industries.
    - c. Peachtree.
    - d. RBI Structures.
- B. Aluminum Canopies: Decking, beams, posts, columns, gutters, and fascia shall be 6063 alloy T-6 temper extruded aluminum.
- C. Brackets and Reinforcements: Provide manufacturer's standard high-strength brackets and reinforcements. Provide nonstaining, nonferrous shims to install and align metal canopies.

- D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.022-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.
  - 1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
- E. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories; compatible with adjacent materials.
  - 1. Movement Joints: Provide slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
  - 2. Connections to Supporting Structure: ASTM A 307, zinc-coated steel fasteners.
  - 3. Anchor Bolts: ASTM A 307, Grade A, zinc-coated steel anchor bolts.
  - 4. Concrete or Masonry Inserts: Zinc-coated cast-iron, malleable-iron, or steel inserts; hot-dip galvanized according to ASTM A 123.
- F. Bituminous Paint: Cold-applied asphalt mastic paint complying with SSPC-Paint 12, except containing no asbestos, and formulated for 30-mil thickness per coat.

## 2.2 FABRICATION

- A. General: Fabricate and finish metal canopy panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
  - 1. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
  - 2. Fabricate components to drain water passing joints and to drain condensation and moisture occurring or migrating within system to the exterior.
  - 3. Fabricate components to accommodate expansion, contraction, and field adjustment, and to provide for minimum clearance and shimming at perimeters.
  - 4. Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
  - 5. Fit and assemble components to greatest extent practicable before finishing.
  - 6. Fit and secure joints with screw and spline, internal reinforcement, or welding.
  - 7. Reinforce members as required to retain fastener threads.
  - 8. Where fasteners are exposed to view, countersink bolt or screw heads and finish to match framing.
  - 9. Weld components before finishing and in concealed locations to greatest extent practicable to minimize distortion.
  - 10. Before shipping, assemble, mark, and disassemble components that cannot be permanently shop assembled.
  - 11. Prepare framing to receive anchor and connection devices and fasteners.
- B. Support columns and gutter beams shall be designed such that the columns will be notched to create a "saddle" that will receive and secure the gutter beams.

- C. Post and beams shall be mechanically assembled utilizing 3/16" fasteners with a minimum shear stress of 350 lb. Pre-welded or factory-welded connections are not acceptable.
- D. Decking shall be designed with interlocking extruded aluminum members with mechanical fasteners field applied to provide structural integrity for the completed assembly.
- E. Concealed drainage. Water shall drain from covered surfaces into integral gutter beam, downspouts and be connected to boot at underground discharge.
- F. Exposed drainage: Direct water to scuppers connected to type Z drains.
- G. Apply a clean acrylic enamel to each column end terminating in concrete to insulate from electrolyte reaction.

## 2.3 FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.
  - 1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
    - a. Humidity Resistance: 2000 hours.
    - b. Water Resistance: 2000 hours.
  - 1) Color and Gloss: As selected by Architect from manufacturer's full range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

- A. Metal Protection: As follows:



1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Where aluminum will contact pressure-treated wood, separate dissimilar materials by methods recommended by manufacturer.

### 3.3 INSTALLATION

- A. General: Comply with manufacturer's written instructions for protecting, handling, and installing metal canopy components.
  1. Fit frame joints to produce hairline joints free of burrs and distortion.
  2. Rigidly secure nonmovement joints.
  3. Accommodate thermal movements.
  4. Install metal canopy to allow drainage of water with out ponding.
- B. Erection Tolerances: Install metal canopy components true in plane, accurately aligned, and without warp or rack. Adjust framing to comply with the following tolerances:
  1. Variation from Plane: Limit variation from plane or location shown to 1/8 inch in 10 feet; 1/4 inch over total length.
  2. Alignment: Where surfaces abut in line and at corners and where surfaces are separated by less than 3 inches, limit offset from true alignment to less than 1/32 inch; otherwise, limit offset from true alignment to 1/8 inch.

### 3.4 CLEANING

- A. Clean metal canopies immediately after installation according to manufacturer's written recommendations.
  1. Remove temporary protective coverings and strippable coatings from prefinished metal surfaces. Remove labels and markings from all components.

### 3.5 PROTECTION

- A. General: Institute protective procedures and install protective materials as required to ensure metal canopy systems will be without damage at substantial completion.

END OF SECTION 10 73 16

## SECTION 11 30 13 - 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cooking appliances.
  - 2. Refrigeration appliances.
  - 3. Cleaning appliances.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data:
  - 1. Cooking appliances.
  - 2. Refrigeration appliances.
  - 3. Cleaning appliances.
- B. Product Data Submittals: For each product.
  - 1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- C. Sustainable Design Submittals:
  - 1. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.

- D. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.
- E. Product Schedule: For appliances. Use same designations indicated on Drawings.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of appliance.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturers' 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 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

#### 1.8 WARRANTY

- A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period except as qualified below:
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Electric Cooktop and 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, Freezer, and Ice maker, 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: Three 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 PERFORMANCE REQUIREMENTS

- A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design and ICC A117.1.

### 2.2 RESIDENTIAL APPLIANCES

- A. As indicated on drawings.

### 2.3 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, areas, 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 appliances 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

- A. Install appliances according to 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.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 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.
- B. An appliance will be considered defective if it does not pass tests and inspections.
- C. 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 11 30 13

## SECTION 12 21 13 - 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Horizontal louver blinds, polymer slats.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For horizontal louver blinds, include fabrication and installation details.
- C. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long.
- D. Samples for Initial Selection: For each type and color of horizontal louver blind.
  - 1. Include Samples of accessories involving color selection.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For horizontal louver blinds with polymer slats that have been tested for compliance with NFPA 701, for tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency.

#### 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 2 percent of quantity installed for each size indicated, but no fewer than two units of each size.

## 1.7 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.8 DELIVERY, STORAGE, AND HANDLING

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

## 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work 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 SOURCE LIMITATIONS

- A. Obtain horizontal louver blinds from single source from single manufacturer.

## 2.2 HORIZONTAL LOUVER BLINDS, POLYMER SLATS

- A. Flame-Resistance Rating: Comply with NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Slats: Polymers that are lead free, UV stabilized, integrally colored, opaque, and will not crack or yellow; antistatic, dust-repellent treated.
  - 1. Formulation: Polymer/wood composite.
  - 2. Width: 2 inches (51 mm)
  - 3. Thickness: 0.105 inch (2.6 mm)
  - 4. Spacing: Manufacturer's standard
  - 5. Profile: Manufacturer's standard
- C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrail fully encloses operating mechanisms on three sides and ends.
  - 1. Capacity: One blind per headrail unless otherwise indicated.
  - 2. **Manual Lift Mechanism:**
    - a. **Cordless Lifting Blinds: Mechanism operation includes pushing up on the bottom rail to raise and pull down on the bottom rail to lower.**
  - 3. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
    - a. Tilt: Full.
    - b. Operator: Corrosion-resistant steel rod
    - c. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.
- D. Bottom Rail: Secures and protects ends of ladders and lift cords.
  - 1. Type: Manufacturer's standard.
- E. Lift Cord: 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: Between Jamb Inside mount brackets with blinds recessed into the depth of the window opening and the brackets mounted to the inside face of the window jambs.
  - 2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by horizontal louver 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 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 (23 deg C):
  1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch (6 mm) per side or 1/2 inch (13 mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).
- C. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
  1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
- D. Mounting 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.
- F. Color-Coated Finish:
  1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

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 of the Work.
- B. 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 according to manufacturer's written instructions.
  - 1. Locate in depth of window opening so interior face of blinds aligns with interior face of exterior wall.
  - 2. Install mounting and intermediate brackets to prevent deflection of headrails.
  - 3. Install with clearances that prevent interference with adjacent construction.

### 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 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 12 21 13

## SECTION 12 24 13 - ROLLER WINDOW SHADES

### 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Manually operated, single-roller shades.
  - 2. Motor-operated, single-roller shades.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
  - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- C. Samples for Verification: For each type of roller shade.
  - 1. Shadeband Material: Not less than 10 inches square. Mark inside face of material if applicable.
  - 2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
  - 3. Installation Accessories: Full-size unit, not less than 10 inches long.
- D. Roller-Shade Schedule: Use same designations indicated on Drawings.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Product Certificates: For each type of shadeband material, signed by product manufacturer.
- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals.

#### 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. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

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

#### 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction 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 roller shades 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. Basis-of-Design: Subject to compliance with requirements, provide Basis-of-Design products indicated or comparable products by one of the following:
  - 1. Lutron Electronics Co., Inc.
  - 2. SWF Contract.
  - 3. MechoShade Systems, Inc.
  - 4. Draper, Inc.
- B. Source Limitations: Obtain roller shades from single source from single manufacturer.

### 2.2 MANUALLY OPERATED, SINGLE-ROLLER SHADES

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
  - 1. Bead Chains: Nickel-plated metal.
    - a. Loop Length: Full length of roller shade.
    - b. Limit Stops: Provide upper and lower ball stops.
    - c. Chain-Retainer Type: Chain tensioner, jamb mounted.
  - 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
    - a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
  - 1. Roller Drive-End Location: Right side of interior face of shade.
  - 2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
  - 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Shadebands:

1. Shadeband Material: Light-filtering fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
  - a. Type: Enclosed in sealed pocket of shadeband material.
  - b. Color and Finish: As selected by Architect from manufacturer's full range.

F. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
  - a. Shape: L-shaped.
  - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.
2. Endcap Covers: To cover exposed endcaps.
3. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
  - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 6 inches.
  - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.

## 2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
    - a. Electrical Characteristics: Single phase, 110 V, 60 Hz.
  3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
    - a. Individual/Group Control Station: Maintained-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
    - b. Color: As selected by Architect from manufacturer's full range.
  4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.

5. Operating Features:
  - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
  1. Roller Drive-End Location: Right side of inside face of shade.
  2. Direction of Shadeband Roll: Regular, from back of roller.
  3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.
- E. Shadebands:
  1. Shadeband Material: Light-filtering fabric.
  2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type: Enclosed in sealed pocket of shadeband material.
    - b. Color and Finish: As selected by Architect from manufacturer's full range.
- F. Installation Accessories:
  1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Shape: L-shaped.
    - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 4 inches.
  2. Endcap Covers: To cover exposed endcaps.
  3. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
    - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than 6 inches.
    - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.

## 2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
  - 1. Source: Roller-shade manufacturer.
  - 2. Roll Width: Width to cover window system with one panel frame to frame.
  - 3. Orientation on Shadeband: Up the bolt.
  - 4. Openness Factor: 3 percent unless otherwise indicated.
    - a. Basis-of-Design: Lutron Performance Collection, “E Screen – Theia” unless otherwise indicated.
  - 5. Color: As indicated.

## 2.5 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop 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. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
  - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
  - 2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of



connections to building electrical system, and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

### 3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

### 3.4 CLEANING AND PROTECTION

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

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 12 24 13

## SECTION 12 36 61.16 - SOLID SURFACING 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Solid surface material countertops.
  - 2. Solid surface material backsplashes.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
  - 1. Show locations and details of joints.
  - 2. Show direction of directional pattern, if any.
- C. Samples for Verification: For the following products:
  - 1. Countertop material, 6 inches square.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for 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 countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
  - 1. Build mockup of typical countertop as shown on Drawings.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

## 1.8 COORDINATION

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

## PART 2 - PRODUCTS

### 2.1 SOLID SURFACE COUNTERTOP MATERIALS (SS-1 & SS-2)

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA.
  - 1. Basis-of-Design Products: Subject to compliance with requirements, provide Basis-of-Design products as indicated on the finish schedule or comparable by one of the following:
    - a. Wilsonart (Basis-of Design).
    - b. Corian.
    - c. E.I. du Pont de Nemours and Company.
    - d. LG Chemical.
  - 2. Type: Provide Standard type unless Special Purpose type is indicated.
  - 3. Colors and Patterns: As indicated on Drawings.
- B. Particleboard: ANSI A208.1, Grade M-2.
- C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

## 2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
  - 1. Grade: Custom.
- B. Configuration:
  - 1. Front: Straight, slightly eased at top.
  - 2. Backsplash: Straight, slightly eased at corner.
  - 3. End Splash: Matching backsplash.
- C. Countertops: 1/2-inch- thick, solid surface material with front edge built up with same material.
- D. Backsplashes: 1/2-inch- thick, solid surface material.
- E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
  - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints: Fabricate countertops without joints to greatest extent possible.
- G. Joints: Fabricate countertops in sections for joining in field.
  - 1. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
  - 2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
- H. Cutouts and Holes:
  - 1. Undercounter Plumbing Fixtures: Make cutouts for 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.
    - b. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch into fixture opening.
    - c. Provide 3/4-inch full bullnose edges projecting 3/8 inch into fixture opening.
  - 2. Counter-Mounted Plumbing 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, grommets, and similar items.

- a. Grommets located above power locations beneath countertops. Coordinate with drawings.

## 2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
  - 1. Adhesives shall have a VOC content of 70 g/L or less.
- B. Sealant for Countertops: Comply with applicable requirements in Section 07 92 00 "Joint Sealants."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill 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.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. 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.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
  - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.

2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
  1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

END OF SECTION 12 36 61.16

## SECTION 12 36 61.19 – QUARTZ AGGLOMERATE 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Quartz agglomerate countertops and backsplashes.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
  - 1. Show locations and details of joints.
  - 2. Show direction of directional pattern, if any.
- C. Samples: For each type of material exposed to view.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For quartz agglomerate material countertops to include in maintenance manuals. Include Product Data for 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 countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
  - 1. Build mockup of typical countertop as shown on Drawings.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

## 1.8 COORDINATION

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

# PART 2 - PRODUCTS

## 2.1 COUNTERTOP MATERIALS

- A. 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 SS1.
  - 1. Basis of Design Products: Subject to compliance with requirements, provide products as indicated on the finish schedule or comparable by one of the following:
    - a. Wilsonart (Basis-of Design)
    - b. E.I. du Pont de Nemours and Company.
    - c. LG Chemical.
    - d. Cambria.
  - 2. Colors: As indicated on Drawings.
- B. Particleboard: ANSI A208.1, Grade M-2.
- C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.



## 2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to quartz agglomerate material manufacturer's written instructions and to the AWI/AWMAC/WT's "Architectural Woodwork Standards."
  - 1. Grade: Custom.
- B. Configuration:
  - 1. Front: Straight, slightly eased at top.
  - 2. Backsplash: Straight, slightly eased at corner.
  - 3. End Splash: Matching backsplash.
- C. Countertops: 3/4-inch- thick (2cm), quartz agglomerate material with front edge built up with same material.
- D. Backsplashes: 3/4-inch- thick (2cm), quartz agglomerate material.
- E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with quartz agglomerate material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
  - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints: Fabricate countertops without joints to greatest extent possible.
- G. Joints: Fabricate countertops in sections for joining in field.
  - 1. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
  - 2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
- H. Cutouts and Holes:
  - 1. Undercounter Plumbing Fixtures: Make cutouts for 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.
    - b. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch into fixture opening.
    - c. Provide 3/4-inch full bullnose edges projecting 3/8 inch into fixture opening.
  - 2. Counter-Mounted Plumbing 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, grommets, and similar items.
  - a. Grommets located above power locations beneath countertops. Coordinate with drawings.

## 2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate material manufacturer.
  1. Adhesives shall have a VOC content of 70 g/L or less.
- B. Sealant for Countertops: Comply with applicable requirements in Section 07 92 00 "Joint Sealants."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
  1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

END OF SECTION 12 36 61.19

## SECTION 14 21 00 - ELECTRIC TRACTION 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes: Modernization of two elevator cabs as described herein and indicated in the drawings.
- B. Elevator No. 1:
  - 1. Update software for existing controller to remain.
  - 2. Adjust existing machine to remain.
  - 3. Adjust existing governor to remain.
  - 4. Elevator car:
    - a. Provide crosshead data tag for existing car slings.
    - b. Provide new car top railing.
    - c. Provide new toe guard.
    - d. Provide new fan grill.
    - e. Provide new two-speed fan.
  - 5. Elevator cab:
    - a. Provide new steel cab enclosure to meet current IBC stretcher requirements.
    - b. Provide new finishes as indicated.
    - c. Provide new car door and sill.
  - 6. Elevator Door Equipment
    - a. Provide new car header.
    - b. Provide new car tracks.
    - c. Provide new clutch.
    - d. Provide new door detector.
    - e. Provide new door operator for side slide configuration.
    - f. Provide new gate switch.
    - g. Provide new hoistway frames with struts, header, partial fascia, dust cover, front; finishes as indicated.

- h. Provide new hoistway doors with sight guards, gibs, escutcheons, front; finishes as indicated.
  - i. Provide new hoistway sills, front; finishes as indicated.
  - j. Provide new sill support angles.
  - k. Provide new hoistway door equipment including tracks, hangers, interlocks, pickups, reel closers, front; finishes as indicated.
- 7. Car fixtures: Provide new main car station.
- 8. Hall fixtures:
  - a. Provide new Combination Hall Lantern/PI.
  - b. Provide new Terminal Hall Stations.
  - c. Provide new Intermediate Hall Stations.
  - d. Finishes as indicated.

C. Elevator No. 2:

- 1. Update software for existing controller to remain.
- 2. Adjust existing machine to remain.
- 3. Adjust existing governor to remain.
- 4. Elevator car:
  - a. Provide crosshead data tag for existing car slings.
- 5. Elevator cab: Provide new finishes as indicated.
- 6. Elevator Door Equipment: Retain and adjust existing except as indicated below:
  - a. Provide new door detector.
  - b. Provide new hoistway doors with sight guards, gibs, escutcheons, front; finishes as indicated.
  - c. Provide new hoistway sills, front; finishes as indicated.
  - d. Provide new sill support angles.
  - e. Provide new hoistway door equipment including tracks, hangers, interlocks, pickups, reel closers, front; finishes as indicated.
  - f. Provide new hoistway frames with struts, header, partial fascia, dust cover, front; finishes as indicated.
- 7. Car fixtures: Provide new main car station.
- 8. Hall fixtures:
  - a. Provide new Combination Hall Lantern/PI.

1.3 DEFINITIONS

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

#### 1.4 ACTION SUBMITTALS

- A. Product Data Submittals: 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, 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 Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch-square Samples of sheet materials; and 4-inchlengths of running trim members.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as indicated on Drawings, and electrical service including standby power generator, as shown and specified, are adequate for elevator system being provided.
- C. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
  - 1. Submit manufacturer's or Installer's standard operation and maintenance manual, according to ASME A17.1/CSA B44, including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.
- 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 or an authorized representative who is trained and approved by 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 inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction 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: One year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain electric traction elevator equipment and components from single manufacturer.
  - 1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, to be manufactured by single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

## 2.3 ELECTRIC TRACTION ELEVATORS

- 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. Basis of design: TKE (ThyssenKrupp Elevator).
  - 2. Otis Worldwide Corporation.
  - 3. Schindler Elevator Corp.
- B. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components to be used, as included in standard elevator systems and as required for complete system.
- C. Elevator No. 1 Description:
  - 1. Elevator Number: No. 1
  - 2. Existing Machine Type: Geared traction.
  - 3. Existing Rated Load: 3000 lb.
  - 4. Existing Rated Speed: 350 fpm.
  - 5. Stops: 11.
  - 6. Operation System: Group automatic operation.
  - 7. Auxiliary Operations:
    - a. Standby power operation.
    - b. Automatic dispatching of loaded car.
    - c. Nuisance-call cancel.
    - d. Loaded-car bypass.
    - e. Automatic operation of lights and ventilation fans.
    - f. Independent service for all cars in group.
  - 8. Security Features: Card-reader operation and keyswitch operation.
  - 9. Car Enclosures:
    - a. Inside Width: Not less than 80 inches from side wall to side wall.
    - b. Inside Depth: 66 inches from back wall to front wall (return panels).
    - c. Inside Height: Not less than 93 inches to underside of ceiling.
    - d. Front Walls (Return Panels): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
    - e. Vandal resistant buttons.
    - f. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
    - g. Side and Rear Wall Panels: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
    - h. Door Faces (Interior): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
    - i. Door Sills: Aluminum.
    - j. Ceiling: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
    - k. Handrails: 1/2 by 2 inches rectangular satin stainless steel, at sides and rear of car.
    - l. Floor prepared to receive resilient flooring (specified in Section 096516 "Resilient Sheet Flooring").
    - m. Non-branded interior.



10. Hoistway Entrances:

- a. Width: 42 inches.
- b. Height: 84 inches.
- c. Type: Single-speed side sliding.
- d. Frames: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
- e. Doors and Transoms: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
- f. Sills: Aluminum.

11. Hall Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.

- a. Vandal resistant buttons.

12. Additional Requirements:

- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, ASTM A480/A480M, No. 4 finish.
- b. Provide hooks for protective pads in all cars and one complete set of full-height protective pads.

D. Elevator No. 2 Description:

- 1. Elevator Number: No. 2
- 2. Existing Machine Type: Geared traction.
- 3. Existing Rated Speed: 350 fpm.
- 4. Existing Stops: 11.
- 5. Operation System: Group automatic operation.
- 6. Auxiliary Operations:
  - a. Standby power operation.
  - b. Automatic dispatching of loaded car.
  - c. Nuisance-call cancel.
  - d. Loaded-car bypass.
  - e. Automatic operation of lights and ventilation fans.
  - f. Independent service for all cars in group.
- 7. Security Features: Card-reader operation and keyswitch operation.
- 8. Car Enclosures:
  - a. Front Walls (Return Panels): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - b. Vandal resistant buttons.
  - c. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - d. Side and Rear Wall Panels: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - e. Door Faces (Interior): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - f. Door Sills: Aluminum.
  - g. Ceiling: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - h. Handrails: 1/2 by 2 inches rectangular satin stainless steel, at sides and rear of car.

- i. Floor prepared to receive resilient flooring (specified in Section 096516 "Resilient Sheet Flooring").
  - j. Non-branded interior.
- 9. Hoistway Entrances:
  - a. Width: Existing.
  - b. Height: Existing.
  - c. Type: Single-speed center opening.
  - d. Frames: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - e. Doors and Transoms: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - f. Sills: Aluminum.
- 10. Hall Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - a. Vandal resistant buttons.
- 11. Additional Requirements:
  - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, ASTM A480/A480M, No. 4 finish.
  - b. Provide hooks for protective pads in all cars and one complete set of full-height protective pads.

## 2.4 OPERATION SYSTEMS

- A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.
- B. Auxiliary Operations:
  - 1. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at fire-command station. Manual operation causes automatic operation to cease.
  - 2. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
  - 3. 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.
  - 4. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
  - 5. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed and distributed in predetermined zones throughout the building. One zone to include the main floor and adjacent floors; remaining floors to be divided into approximately equal zones.
  - 6. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when

car is in independent service. When in independent service, doors close only in response to door close button.

7. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.

C. Security features are not to not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at car-control stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space for card reader in car.
  - a. Security access system equipment is not in the Contract.
2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car-control stations and hall push-button stations. Key is removable only in deactivated position.
3. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes all cars in a group to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

## 2.5 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 causes 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 sounds and doors begin to close at reduced kinetic energy.

## 2.6 CAR ENCLOSURES

- A. Provide enameled or powder-coated 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:
    - a. Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.

2. Floor Finish: Resilient tile flooring.
3. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
4. Fabricate car with recesses and cutouts for signal equipment.
5. Fabricate car door frame integrally with front wall of car.
6. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet.
7. Sight Guards: Provide sight guards on car doors.
8. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
9. Ceiling: Metal flush panels, with four low-voltage downlights in each panel.
10. Light Fixture Efficiency: Not less than 35 lumens/W.
11. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

## 2.7 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 to accommodate hoistway wall construction.
  1. Where gypsum board wall construction is indicated, frames to be self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies to 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.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
  1. Stainless Steel Frames: Formed from stainless steel sheet.
  2. Stainless Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from stainless steel sheet.
  3. Sight Guards: Provide sight guards on doors matching door edges.
  4. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
  5. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

## 2.8 SIGNAL EQUIPMENT

- A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide vandal-resistant buttons and lighted elements illuminated with 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.
1. Emergency Communication System to comply with South Carolina Building Code 3001.2.
- D. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet with telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication.
- E. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- F. Hall Push-Button Stations: Provide one hall push-button station at each landing.
1. Provide units with flat faceplate for mounting with body of unit recessed in wall.
  2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
  3. Provide telephone jack in each unit for firefighters' two-way telephone communication service.
- G. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:
1. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
- H. 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.
- I. Hall Position Indicators: Provide digital-display-type position indicators, located above each hoistway entrance at ground floor. Provide units with flat faceplate and with body of unit recessed in wall.
1. Integrate ground-floor hall lanterns with hall position indicators.
- J. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.

- K. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
- L. 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.

## 2.9 FINISH MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.
- D. Stainless Steel Bars: ASTM A276/A276M, Type 304.
- E. Stainless Steel Tubing: ASTM A554, Grade MT 304.
- F. Aluminum Extrusions: ASTM B221, Alloy 6063.

## 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. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; 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 OF ELECTRIC TRACTION ELEVATOR COMPONENTS

- A. Comply with manufacturer's written instructions.
- 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 standards for workmanship and for qualifications of welding operators.

- 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. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
- E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- F. Leveling Tolerance: 1/8 inch, up or down, regardless of load and travel direction.
- G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- H. Locate hall signal equipment for elevators as follows unless otherwise indicated:
  - 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
  - 2. Place hall lanterns either above or beside each hoistway entrance.
  - 3. 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. Operating Test: Load each elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
- C. 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. Existing Equipment to Remain: Provide protection from weather and new construction for existing equipment to remain. Maintain temporary conditioned space at existing equipment to remain in accordance with elevator equipment manufacturer's recommendations and installation procedures.
- B. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for 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 MAINTENANCE SERVICE

- A. Per existing maintenance service agreement with Owner.

### 3.6 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 14 21 00



## SECTION 21 00 10 - GENERAL PROVISIONS – FIRE PROTECTION

### PART 1 - GENERAL

#### 1.1 SCOPE:

- A. Bids of work covered by each section of these specifications shall be based on the “Fire Protection Sprinkler System Specification Sheet”. Because of small scale of drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Contractor shall carefully investigate structural and finish conditions affecting his work and shall arrange such work accordingly as may be required to meet such conditions. Where locations make it necessary or desirable from Contractor's standpoint to make changes in arrangements or details shown on drawings, he may present suggestions for such changes and obtain Engineer's approval prior to making such changes.

#### 1.2 CODES:

- A. All work under this division shall be in strict compliance with the International Building Code – 2021 Edition with SC modifications, the International Fire Code – 2021 Edition with SC modifications, NFPA 13 – 2019 Edition, NFPA 14 – 2019 Edition, NFPA 20 - 2019 Edition, and all applicable Codes and Regulations of the Authority Having Jurisdiction.

#### 1.3 MATERIAL AND SHOP DRAWINGS:

- A. Use only new materials and the standard product of a single manufacturer for each article of its type unless specifically mentioned otherwise. Materials and workmanship in the case of assembled items shall conform to the latest applicable requirements of NFPA, NEC, ASTM, and ANSI.
- B. Schedule submittals to expedite work. Unless otherwise indicated in this Section, submittals shall be submitted within 30 days of date of Notice to Proceed. Provide electronic copies of submittals for review and approval. All submittals shall be emailed in a single volume. Partial lists will not be considered and will be returned to the Contractor. Identify Project, Contractor, subcontractor, supplier, manufacturer, pertinent drawing sheet and detail numbers, and associated specification section numbers. Identify variations from requirements of Contract Documents. Any submittal that exceeds 10 MB shall be transferred using Dropbox or other similar file sharing service.
- C. Contractor responsibilities:
  - 1. Review submittals prior to transmittal. Verify compatibility with field conditions and dimensions, product selections and designations, quantities, and conformance of submittal with requirements of Contract Documents. Return non-conforming submittals to preparer for revision rather than submitting to Engineer. Coordinate submittals to avoid conflicts between various items of work. Failure of Contractor to review submittals prior to transmittal to Engineer shall be cause for rejection. Incomplete, improperly packaged, and submittals from sources other than

Contractor will not be accepted. Submittals not stamped APPROVED and signed by the Contractor will be returned to the Contractor.

2. Prepare drawings illustrating portion of work for use in fabricating, interfacing with other work, and installing products. All equipment submitted shall be of adequate size and physical arrangement to allow unobstructed access when installed, for routine maintenance and other similar operations. Contract Drawings shall not be reproduced and submitted as shop drawings. Title each drawing with Project name and reference the sheet the drawing corresponds to. Drawings shall be in compliance with the requirements of NFPA 13 - 27.1.3. A ¼”/foot plan shall be produced and submitted of the fire pump room.
3. Provide product data such as manufacturer's brochures, catalog pages, illustrations, diagrams, tables, performance charts, and other material which describe appearance, size, attributes, code and standard compliance, ratings, and other product characteristics. Provide all critical information such as reference standards, performance characteristics, capacities, power requirements, wiring and piping diagrams, controls, component parts, finishes, dimensions, and required clearances. Submit only data which are pertinent. Mark each copy of manufacturer's standard printed data to identify products, models, options, and other data pertinent to project.
4. Engineer will review and return submittals with comments. Do not fabricate products or begin work which requires submittals until return of submittal with Engineer acceptance. Promptly report any inability to comply with provisions. Revise and resubmit submittals as required within 15 days of return from Engineer. Make re-submittals under procedures specified for initial submittals. Identify all changes made since previous submittal.

D. Engineer Review:

1. Detailed drawings, including proposed head layouts, shall be prepared by the Fire Protection Contractor. These drawings shall be submitted to the Engineer for their approval. Upon approval by the engineer, it shall be the responsibility of the engineer of record to submit the approved shop drawings to the Office of the State Fire Marshal for their approval. All approvals shall be received prior to starting work. Upon receipt of the approval from the Office of the State Fire Marshal, the fire sprinkler contractor shall provide one set of approved shop drawings to the Office of the State Engineer, one set to the Clemson University Fire Code Official, and one set to the Town of Clemson Fire Department for their records.

E. Items Requiring Submittal are as Follows:

1. All items listed in MANUFACTURERS: Section of 21 00 10

1.4 ASBESTOS:

- A. At any time, the Contractor encounters asbestos, he shall immediately stop work in the immediate area and suspend any further work until asbestos is removed. Contractor shall,

upon discovery of asbestos, notify owner, or owner's representative, who shall be responsible for the removal of the asbestos, all in accordance with NESHAP (National Emission Standard for Hazardous Air Pollutants). Any form of asbestos removal or demolition shall be by owner. Engineer is not an "Owner or Operator" as defined under NESHAP.

- B. Contractor is responsible for and shall be aware of all state and federal laws pertaining to asbestos as well as NESHAP requirements.

#### 1.5 PERMITS AND FEES:

- A. Obtain permits, licenses, pay fees, etc. as required for performance of Contract. Arrange for necessary inspections required by governing authority and deliver certificates of approval to Architects or their representatives. File plans as required by the governing body.

#### 1.6 DEFINITIONS:

- A. In this division of the specifications and accompanying drawings, the following definitions apply:
  - 1. Provide/Install: To purchase, pay for, transport to the job site, unpack, and connect complete and ready for operation; to include all permits, inspections, equipment, material, labor, hardware, and operations required for completion and operation.

#### 1.7 CUTTING AND PATCHING:

- A. Cutting of walls, floors, roofs, partitions, and ceiling, required for proper installation of the systems shall be performed under this contract.
- B. Cutting shall be done in a neat, workmanlike manner. No joist, beams, girders, columns, or other structural members may be cut without written permission from the Engineer. When possible, holes shall be saw-cut or core drilled neat to minimize patching.
- C. Patching shall be performed to match existing structures, exterior walls and roofs, and shall form watertight installation.

#### 1.8 VERIFICATION OF DIMENSIONS, ETC.:

- A. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work, working conditions, verify all dimensions in the field, advise the Engineer of any discrepancy, and submit shop drawings of any changes he proposes to make for approval before starting the work. Contractor shall install all equipment in a manner to avoid building interference.

#### 1.9 COORDINATION WITH OTHER TRADES:

- A. Coordinate all work of each section with work of other sections to avoid interference. Bidders are cautioned to check their equipment against space available as indicated on

drawings and shall make sure that proposed equipment can be accommodated. Before beginning work under each section, inspect installed work of other trades and verify that such work is complete to the point where the installation may properly begin.

1.10 PROTECTION OF ADJACENT WORK:

- A. Protect work and adjacent work at all times with suitable covering. All damage to work in place caused by Contractor shall be repaired and restored to original good and acceptable condition using same quality and kinds of materials as required to match and finish with adjacent work.

1.11 FIRESTOPPING:

- A. Provide firestopping for all mechanical penetrations through fire resistant walls and shaft enclosures, and floor, ceiling, and roof elements of fire resistant assemblies. Firestopping shall provide rating comparable to rating of structure it protects.
- B. Firestopping materials currently classified with UL as "Through Penetration Firestop Systems".
- C. Firestopping materials shall have been tested in accordance with UL 1479 "Fire Tests of Through Penetration Firestops".

1.12 CLEAN-UP:

- A. At the completion of the contract work, all areas where work has been performed shall be left clean. All trash shall be removed from the site by the Contractor.

1.13 APPROVALS AND SUBSTITUTIONS:

- A. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such references shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, or type of construction which, in the judgment of the Engineer, expressed in writing, is equal to that specified.
- B. Requests for written approval to substitute materials or equipment considered by the Contractor as equal to those specified, shall be submitted for approval to the Engineer ten (10) days prior to bid date. Requests shall be accompanied by samples, descriptive literature and engineering information as necessary to fully identify and evaluate the product. No increase in the contract sum will be considered when requests are not approved.

1.14 AS-BUILT DRAWINGS:

- A. The Contractor shall keep a record set of drawings on the job; and as construction progresses shall show the actual installed location of all items, material, and equipment on these job drawings. Indicate approved changes in red ink.

- B. At the time of final completion, a corrected set of As-Built drawings shall be delivered to the Engineer. A final set of reproducible drawings with job information that reflects the actual installation shall be prepared by the fire sprinkler contractor and given to the Owner along with a set of approved fire sprinkler shop drawings.

1.15 WARRANTY:

- A. The Contractor for each section of the work under this division will furnish to the Owner a written warranty for the installation as installed of all equipment covered under each section of the specifications, to perform in a satisfactory manner with no more than normal service.
- B. Each warranty shall extend for a period of one year following substantial completion and acceptance of construction. They shall be endorsed by the Contractor.

1.16 MANUFACTURERS:

- A. In order to define requirements for quality and function of manufactured products, and requirements such as size, gauges, grade selection, color selections and like specifications requirements, the specifications as written hereinafter are based upon products of those manufacturers who are named hereinafter under various specifications for materials.
- B. In addition to products of manufacturers named hereinafter in the specifications, equivalent products of the following named manufacturers will be acceptable under the base bid:
  - 1. Pipe Hangers:
    - a) Cooper B-Line, Fee and Mason Manufacturing Company, Anvilstar International, Erico Caddy, Tolco a Division of Nibco
  - 2. Fire Protection Valves, Fire Department Connections, Test Headers, etc.:
    - a) Potter-Roemer, Inc., Fire End & Croker Corporation, Guardian Fire Equipment, Inc.
  - 3. Sprinklers:
    - a) Reliable Automatic Sprinkler Company (to be provided by owner), Tyco, Viking (where not provided by owner)
  - 4. Fire Pump:
    - a) Xylem A-C Fire Pump, Patterson Pumps, Peerless
  - 5. Backflow Preventers:
    - a) Watts Industries, Ames Fire & Waterworks, Zurn Wilkins

6. Identification Items

- a) Seton Name Plate Company, W.H. Brady Company, Handley Industries, Inc.

PART 2 - PRODUCTS

2.1 PAINTING:

- A. Furnish touch up paint supplied by equipment manufacturer.

2.2 NAME PLATES:

- A. All equipment provided under this division shall be labeled with a Bakelite nameplate 1" x 3" minimum with 3/8" minimum height lettering as manufactured by Seton Name Plate Company.

2.3 VALVES:

- A. All valves provided under each section shall be of a single manufacturer unless otherwise specified.

2.4 FIRESTOPPING MATERIALS:

- A. The material used to fill the annular space shall prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E 119 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inches of water at the location of the test specimen for the time period equivalent to the fire resistance rating of the construction penetrated. Material shall be capable of curing in the presence of atmospheric moisture to produce durable and flexible seal and will form airtight and watertight bonds with most common building materials in any combination including cement, masonry, steel, and aluminum.

2.5 SLEEVES AND OPENINGS:

- A. Provide UL certified fire stop sleeving system for all pipe penetrations through fire rated walls, floors, partitions, ceilings, floor-ceiling assemblies, and roofs as tested under ASTM E814 "Standard Method of Fire Tests of Through Penetration Fire Stops".

2.6 SEISMIC RESTRAINTS:

- A. Complete installation of fire protection system shall meet the seismic requirements including longitudinal bracing, sway bracing, and four way bracing as required by NFPA 13 – 2019 Edition.

## PART 3 - EXECUTION

### 3.1 CONCRETE EQUIPMENT FOUNDATIONS:

- A. Consult ASHRAE: A Practical Guide to Seismic Restraint, Chapter 6 for specific reinforcement and anchoring details, with respect to pad size and seismic forces. Unless otherwise noted, set all floor mounted and "on-grade" mounted equipment on 6" high concrete foundation pads. Concrete foundations shall be reinforced with #4 bars - 12" o.c. both ways, or as directed by A Practical Guide to Seismic Restraint. Pads shall be approximately 6" larger than equipment base, and have 1" x 1" chamfer on all edges. Pads shall have carborundum brick rubbed finish. Surface finish shall be uniformly smooth. Concrete floor shall be rough and foundation doweled to floor per A Practical Guide to Seismic Restraint.

### 3.2 PIPE FITTINGS:

- A. General: Provide complete systems of piping and fittings for all services as indicated. All pipe, valves, and fittings shall comply with American National Standards Institute, Inc. Code and/or local codes and ordinances. Cut pipe accurately to measurements established at building or site, and work into place without springing or forcing, properly clearing all windows, doors, and other openings or obstructions.
- B. Excessive cutting or other weakening of building to facilitate piping installation will not be permitted. Piping shall line up flanges and fittings freely. Test all piping prior to concealing.

### 3.3 PIPE:

- A. All piping material shall be as specified in other sections of this division.

### 3.4 SLEEVES:

- A. Provide all sleeves in floors, beams, wall, roof, etc. as required for installing work of this division unless otherwise specified hereinafter. Sleeves thru fire-rated assemblies shall be firestopped as specified herein and insulation shall not pass thru sleeve unless material complies with firestopping specified.

### 3.5 PIPE HANGERS, SUPPORTS AND INSERTS:

- A. Pipe hangers, supports and inserts shall comply with the requirements of NFPA.
- B. Hanger or Support Spacing (unless specified different hereinafter):
- C. Hanger or support maximum spacing shall be as required by NFPA.

3.6 CLEANING:

- A. All surfaces on metal, pipe, insulation covered surfaces, and other equipment furnished and installed under this division of the specifications shall be thoroughly cleaned of grease, scale, dirt, and other foreign material.

3.7 TESTING (PIPING):

- A. Upon completion of each system of work under this division, and at a designated time, all piping shall be pressure tested for leaks in the presence of the owner or third party inspecting agency. Owner or testing agency shall be notified five days before testing is to be conducted and all tests shall be conducted in their presence. All equipment required for test shall be furnished by contractor at his expense. All tests shall be performed as specified hereinafter. If inspection or tests show defects, such defective work or material shall be replaced, and inspection and tests repeated at no additional cost to owner. Make tight any leaks. Repeat tests until system is proven tight. Caulking of leaks will not be permitted. All equipment not capable of withstanding the test pressure shall be valved off during the test.
- B. All sprinkler piping shall be tested hydrostatically at not less than 200 pounds per square inch pressure for two hours and shall meet all requirements of Underwriters. All standpipe piping shall be tested hydrostatically at not less than 300 pounds per square inch pressure for two hours and shall meet all requirements of Underwriters.

3.8 IDENTIFICATION OF PIPING:

- A. All piping, bare and insulated in main mechanical room, shall be given two coats of finish painting by this contractor as listed hereinafter. Paint shall be Glidden Industrial Enamel, or equal by Sherwin-Williams or Devoe Paints. Samples of colors and type paint shall be submitted for approval prior to application.

3.9 PIPE CODING:

- A. After all piping has been painted with color-coding where applicable, all piping installed under this division, regardless of painting, shall be coded and marked with "Perma-Code" pipe markers as manufactured by W.H. Brady Company, 712 Glendale Avenue, Milwaukee, Wisconsin. Markers shall be applied to properly identify piping, but in no case shall they be applied more than 20 feet apart. Markers shall be 1-1/8 inch by 7 inches and shall be secured by spiral wrapping with 3/4 inch wide vinyl banding tape, color matching service, at each end of marker.

3.10 OPERATION AND MAINTENANCE INSTRUCTIONS, AND MAINTENANCE MANUAL:

- A. Upon completion of work, and at a time designated by the engineer, a competent employee of the contractor shall be provided to instruct a representative of the owner in the operation and maintenance of the system.
- B. Minimum instruction period shall be:
  - 1. Fire Protection System - 1/2 day



- C. Maintenance Manuals: The contractor shall compile and bind five (5) sets of all manufacturer's instructions and descriptive literature on all items of equipment furnished under this work. These instructions shall be delivered through the general contractor to the engineer for approval prior to final inspection.
- D. Instructions shall include:
  - 1. Warranty letter signed by the Fire Protection Contractor.
  - 2. Index for each section with each section properly identified.
  - 3. Complete equipment list with model and serial numbers.
  - 4. Copy of one complete, approved submittal for each equipment section.
  - 5. Description of each system, including manufacturer's literature for all items.
  - 6. Start-up and shut-down description for each system.
  - 7. Suggested operating and maintenance instructions with frequency of maintenance indicated.
  - 8. Parts list for all items of equipment.
  - 9. Copy of NFPA 25 "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems".
- E. Manuals shall be 8-1/2 x 11 inch text pages in digital PDF format. Prepare binder covers with printed subject title of manual, title of project, date, and volume number when multiple binders are required. Provide a table of contents for each volume. Internally subdivide the binder contents with bookmarks providing a link to each section. Provide directory listing as appropriate with names addresses, and telephone numbers of design consultant, Contractor, subcontractors, equipment suppliers, and nearest service representatives.

End of Section 21 00 10

## SECTION 21 05 00 - FIRE PROTECTION

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. This section of the specifications describes requirements pertaining to Fire Protection. All work shall comply with Section 21 00 10 - General Provisions Fire Protection, the International Fire Code – 2021 Edition with SC modifications, the International Building Code – 2021 Edition with SC modifications, the South Carolina Fire Protection Sprinkler Act, NFPA 13 – 2019 Edition, NFPA 14- 2019 Edition, and NFPA 20 – 2019 Edition.

#### 1.2 SCOPE

- A. This section of these specifications is intended to describe furnishing labor, material, and equipment for the installation of a fire pump, a standpipe system, and wet pipe automatic sprinkler systems.
- B. In all areas, equipment and piping shall be installed so it will not interfere with the air conditioning, heating, ventilating, and electrical systems that must occupy the same general areas.
- C. Contractor shall design an automatic wet system for the entire building as indicated on the project documents and “Fire Protection Sprinkler System Specification Sheet”. All piping shall be sized based on hydraulic calculations using 95 PSIG static and 90 PSIG residual at 1261 GPM taken at hydrant number 104 located on the north side of the Hendrix Center on June 6, 2023. See civil drawings for new fire service.

#### 1.3 COMPLIANCE WITH CODES

- A. The complete installation for the building shall be in accordance with code requirements of City of Clemson Fire Department, the Office of the State Fire Marshal, State Elevator Code (Title 41, Chapter 16), International Building Code – 2021 Edition with SC modifications, International Fire Code – 2021 Edition with SC modifications, South Carolina Fire Protection Sprinkler Systems Act (Title 40, Chapter 10), State Engineers Manual (2018 OSE Manual), NFPA 13 – 2019 Edition, NFPA 14 – 2019 Edition, and NFPA 20 – 2019 Edition.

#### 1.4 SHOP DRAWINGS

- A. Detailed drawings, including proposed head layouts, shall be prepared by the Fire Protection Contractor. These drawings shall be submitted to the Engineer for their approval. Upon approval by the engineer, the engineer of record will be responsible for submitting the approved shop drawings to the Office of the State Fire Marshal and the Clemson Fire Code Official for their approval. All approvals shall be received prior to starting work.

- B. Upon completion of the indicated work, one (1) additional set of approved reproducible drawings showing the entire installation "as built" shall be furnished to the Owner for his files.

## 1.5 SEISMIC REQUIREMENTS

- A. Complete installation of fire protection system shall meet the seismic and restraint requirements including longitudinal bracing, sway bracing, end of branch line restraints, and four way bracing as required.

## PART 2 - PRODUCTS

### 2.1 PRODUCTS

- A. Fire sprinklers, unless otherwise required by the design or noted on the drawings, will be donated by Reliable Automatic Sprinkler Company, Inc. Fire sprinkler contractor shall coordinate required sprinklers based off of their design with Cary Webber, CFPS – Director, Technical Services at 1-864-843-5161.
- B. Sprinkler heads shall be spray type, having 1/2" discharge orifice, with temperature ratings in accordance with Underwriter's specifications unless otherwise noted. Sprinkler heads shall be horizontal sidewall, upright, semi-recessed pendant, or fully concealed flat plate ceiling recessed (except where noted by dry pendent sprinklers), adjustable decorative/glass bulb type as manufactured by the Reliable Automatic Sprinkler Company, or equal as listed in 21 00 10. All heads shall have a white finish or other standard color, except upright heads in area with no ceiling which shall have a brass finish. Sprinklers shall be of temperature rating as required by the application per NFPA including using intermediate temperature rating when located within 30" of the edge of any HVAC diffuser in the ceiling. No oversized escutcheons shall be utilized if the suspended ceiling requires a 1" clearance around the vertical penetrations as required by ASCE7-05. Flexible sprinkler drops with braided hose design shall be used in lieu of any required oversized escutcheons and shall be installed per the manufacturers published instructions. Corrugated, or non-braided, flexible drops will not be allowed.
- C. Sprinkler guards as required in main mechanical room shall be Reliable, or approved equal, Model D-1 consisting of guard, locknuts, and water shield. The guard shall be fabricated of heavy gauge wire welded to steel mounting plates and shall comply with the latest UL standards.
- D. The Contractor shall provide a cabinet with extra sprinkler heads and one (1) sprinkler wrench for each type of sprinkler provided in the building per NFPA 13-16.2.7. Sprinklers shall be properly apportioned as to temperature rating and types of heads used as required by NFPA 13 and shall include a list that shall be in an envelope in the cabinet. Mount cabinet on wall adjacent to fire pump in Fire Pump room.
- E. Pressure Switch: Provide switch with circuit opener or closer for the automatic transmittal of an alarm over the facility fire alarm system and connect into the fire alarm system. Alarm actuating device shall be of the mechanical diaphragm controlled water pressure type with

retard device adjustable from 10 to 60 seconds and shall be of a type which instantly recycles when pressure is released on the diaphragm. Install the switch in the alarm valve trim ahead of all valves so that the switch cannot be shut off.

- F. Waterflow Detector: Provide vane-type waterflow detector. Detector shall have a sensitivity in the range of 4 to 10 gpm and static pressure rating of 450 psi. The detector shall respond to waterflow in a specified direction after a preset adjustable time delay.
- G. Alarm Bell: Provide alarms of the approved weatherproof and guarded type, to sound locally on the flow of water as detected by the waterflow detector in each sprinkler system to which it is connected. Mount alarms on the outside of the outer walls of building at the maximum height of the riser room. Alarm bell shall have underdome strikers and operating mechanisms. Bells shall be suitable for outdoor surface mounting utilizing weatherproof parts. Bells shall be System Sensor, or equal, SSV120-6 series with 120 volt input from the fire alarm panel (with battery back-up) and 6" diameter with WBB weatherproof electrical box. Coordinate all work with fire alarm system installer prior to rough-in.
- H. Inspector's Test Connection: Provide test connections about six feet above the floor for each sprinkler system or portion of each sprinkler system equipped with an alarm device and locate at the hydraulically most remote part of each system. Provide test connection piping to a location where the discharge will be readily visible and where water may be discharged without damage.
- I. System and Auxiliary Drains: All drain locations shall be approved by the A/E team. Exterior drain locations shall be provided with a concrete splash block if not discharging on concrete and shall not be located within 10' of any public doorway. All discharge points shall be within 20' of a catch basin, yard inlet, or other such type of receptor. All interior drain locations shall be approved by the A/E team and shall meet the requirements of NFPA 13-16.10.5. All drain piping shall be galvanized piping of similar schedule and joining methods as listed before for other piping. Drain lines shall connect to storm sewers and shall not interfere with landscaping or public ways.
- J. Backflow Preventer: Provide an Ames, or equal, Series C200 double check valve assembly. Assembly shall consist of two independent Tri-Link check modules within a single housing, sleeve access port, four test cocks and two drip tight shut off valves. Tri-Link checks shall be removable and serviceable, with the use of special tools. The housing shall be constructed of 304 stainless steel pipe with groove end connections. Tri-link checks shall have reversible elastomer discs and in operation shall produce drip tight closure against the reverse flow of liquid. Maximum working pressure shall be 175 psi. Provide service isolation valves before and after.
- K. Fire Pump Test Connection: Test connection shall be Potter-Roemer, or equal, Model 5868 6x2-1/2 4-way header with cast brass angle inlet body. Brass NRS hose gate valves with loose bonnets. Connection shall be complete with 2-1/2" metal caps and chains, 18" long polished brass cover sleeve, and brass identification plate lettered, "Pump Test Connection". Connections shall be by Potter-Roemer, Fire End & Croker Corporation, or Guardian Fire Equipment Inc.

- L. Automatic Air Vent: On wet pipe sprinkler systems utilizing metallic piping, install a Potter Electric Signal Company, or equal, Model PAV automatic air vent located at the high point of the system and off of the top of the piping to allow air to be removed from the system. Provide and install a ball valve and nipple prior to the automatic air vent for maintenance purposes.
- M. All wet pipe sprinkler piping shall be UL listed metallic pipe and materials in accordance with NFPA 13 – 2019 Edition. Piping 4" and larger shall be Schedule 10 black steel rolled-grooved or flanged and all piping 3" and smaller shall be schedule 40 black steel piping with threaded fittings.
- N. All required signage shall be through external fasteners such as U-bolts, clamps, or other approved means that do not drill into the piping system.
- O. Pipes, valves, and fittings for standpipe system shall conform to requirements specifically covering these items as set forth herein. Where specific requirements are not established, the latest requirements of NFPA 14 – 2019 Edition for Class I buildings shall apply. All hose threads shall match the hose of local fire department.

## 2.2 ELECTRIC FIRE PUMP SYSTEM:

- A. General: Provide an electric fire pump system capable of supplying 750 GPM with vertical inline, centrifugal fire pump complete with engine, controllers and accessories as outlined.
- B. The pump shall be designed to deliver 750 GPM and a differential pressure of 100 psi. At 150% of rated capacity, the pump shall develop at least 65% of its rated head and shall not exceed 140% of the rated head at zero capacity. The pump shall be tested at the factory and a test curve shall be submitted showing the performance and horsepower requirements based on this test before final acceptance.
  - 1. The pump should be a single stage, close-coupled vertical inline design, centrifugal fire pump listed by Underwriters Laboratories and/or approved by Factory Mutual. The unit shall meet all the requirements of the National Fire Protection Association Pamphlet No. 20 and shall be an A-C Fire Pump 1580 Series, or approved equal by Patterson, or Peerless Pump Company, mounted on a fabricated steel base, complete with coupling and directly connected to, and to include:
- B. Pump System:
  - 1. Casing shall be of cast iron ASTM A278, Class 30 or 35, or ductile iron ASTM A536, Grade 65, with the suction and discharge flanges located on a common centerline, 180 degrees apart, for mounting in the pipeline. The standard pipe flanges shall be drilled for 125# per ANSI B16.1 standard.
  - 2. Impellers shall be of the enclosed type. Impellers shall be dynamically balanced and keyed to the shaft and held in place with a cap screw and lock washer.
  - 3. The pump shall be rated for a minimum of 175 psi working pressure and a maximum of 370 psi with 250# discharge flanges and ductile iron casing.

4. The casing wear rings shall be made of bronze and can be easily replaced.
5. The pump shall be direct coupled to the motor shaft for easy maintenance, to minimize impeller run out and reduce noise.
6. The pump shall have a vertical back pullout design that makes servicing easier. The rotating element shall be easily removed without disturbing the piping.
7. The pump shall have split bronze packing glands for easy packing replacement.
8. The stuffing box shall be furnished with impregnated yarn packing, lantern ring and a catch basin for piping leakage to drain.
9. The pump shall have gauge tapplings at the suction and discharge nozzles and vent and drain tapplings at the top and bottom.
10. A rubber slinger will be installed on the shaft before the motor to prevent the passage of liquid to the motor.
11. The motor will be the JP frame type.
12. Nameplates and other data plates shall be all corrosion resistant and suitably secured to the pump.
13. Pump manufacture shall be ISO 9001 certified.

C. Controller:

1. UL/FM automatic engine controller. Model FTA 1350 Wye-Delta Closed Fire Pump controller with power transfer switch.
2. Features:
  - a) Built-In Battery Charger
  - b) Weekly Test Start with Solenoid
3. Accessories:
  - a) 1/2" Automatic Air Release Valve
  - b) 1 Set Suction and Discharge Gauges
  - c) Coupling Guard
  - d) Fuel System
  - e) Engine Hot Start
  - f) Battery Rack (12 volt)
  - g) 1 Set (3) 2-1/2" Hose Valves N.S.T. with Caps and Chains
  - h) 6" Outside Hose Header
  - i) 4" Main Relief Valve
  - j) Enclosed Waste Cone

- k) Test Valve
- l) Base Ell
- m) Reducing on the Side Tee
- n) Interlock between diesel generator and - Room ventilation fan
- o) Two auxiliary contacts in control panel

D. Jockey Pump:

1. Centrifugal close-coupled, jockey pump, cast iron, bronze fitted with stainless steel shaft, mechanical seals, impeller wear rings. Pump shall be Goulds, or equal, Model 3SV-9.
2. Design: Designed for 10 GPM, 115 PSI, 3600 RPM complete with vertical open dripproof motor rated for 2 HP.
3. Jockey Pump Controller: Controller complete with fusible disconnect, pressure switch start button and selector switch, all prewired and housed in NEMA III enclosure shall be Firetrol, or equal, FTA 560 jockey control.
4. Accessories: Running period timer and casing relief valve.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Equipment, materials, installation, and workmanship shall be in accordance with NFPA 13 – 2019 Edition, NFPA 14 – 2019 Edition, NFPA 20 – 2019 Edition, and the International Fire Code – 2021 Edition with SC modifications.

3.2 FIELD TESTING AND FLUSHING:

- A. Preliminary Tests: Hydrostatically test each fire sprinkler system at 200 psig for a period of two hours. Hydrostatically test each standpipe system at 300 psig for a period of two hours. Flush piping in accordance with NFPA 13 – 2019 Edition. Piping above suspended ceilings shall be tested, inspected, and approved before installation of ceilings. Test the alarms and other devices. Test the water flow alarms by flowing water through the inspector's test connection. When tests have been completed and corrections made, submit a signed and dated certificate, similar to that specified in NFPA 13 – 2019 Edition and NFPA 14 – 2019 Edition, with a request for a formal inspection and tests.

3.3 KEY PLAN:

- A. Provide a key plan of each level with zones indicated. Plans shall be an 11" x 17" permanent copy, framed under glass and mounted on the wall adjacent to the fire pump.

End of Section 21 05 00





# Fire Sprinkler System Specification Sheet

(Per §40-10-250)



## Project Data

Project name: Bryan Mall High Rises Renovations - Manning Hall

Location in South Carolina: Address (street # & name): 260 Bryan Circle State Project: ☒ Yes ☐ No  
City: Clemson County: Pickens State Project #: H12-9953-JM

## Water Supply Information

(Flow test data must be less than 1 year old per §40-10-250(A)(1))

Date test conducted: 06 / 06 / 2023 Static pressure (psi): 95 Residual pressure (psi): 90 Flow (gpm): 1261

Distances of test gauges relative to the base of the riser: Horizontal (ft): 175' Vertical (elevation difference in ft): -9'

Source of water supply: ☐ Municipal dead-end ☒ Municipal circulation ☐ existing fire pump ☐ Other: Pipe Size (in.): 8"

Test data by/from: Name: Randy Littrell Title: Not Provided  
Organization: Clemson University Water System Phone: 864-656-6203

Fire pump: ☒ New ☐ Existing Rated Pressure (psi): 100 Churn Pressure (psi): 127  
☐ No Pump Rated Capacity (gpm): 750 Pressure @ 150% flow (psi): 77

On-site water storage: ☐ Yes ☒ No ☐ New ☐ Existing ☐ Tank ☐ Other: N/A Capacity (gal): N/A

## NFPA Hazard Classification

(Attach continuation page when necessary)

Area #	Hazard Class or Code Reference	Description of Hazard Protected (including occupancy use group, and details of storage arrangement as applicable (including commodity class, rack arrangement/type, ceiling and storage height.))
1	Light	Residence Rooms, Offices, Public Spaces
2	Ord. Haz. - Gr. I	Equipment Rooms, Storage Rooms, Laundry
SP	NFPA 14 - 2019 Ed.	Automatic Standpipes

## Design Parameters

(Attach continuation page when necessary)

Area #	System Type	Density(gpm/ft <sup>2</sup> )/Area(ft <sup>2</sup> ), or Other (Reference code sections)	Inside Hose (gpm)	Outside Hose (gpm)
1	Wet	0.10/1500	0	100
2	Wet	0.15/1500	0	250
3	Wet	500 gpm @ 100 psi @most remote outlet	---	---

Seismic Design Data: S<sub>s</sub>=0.377 Site Classification=C Seismic Design Category=C

## Codes and Standards

(Attach continuation page when necessary)

### Applicable Codes, Standards, & Editions (i.e. 2018 IBC, 2016 NFPA 13, etc.) for the Scope of Work on the Fire Sprinkler System

2021 International Building Code with SC modifications, 2021 International Fire Code with SC modifications

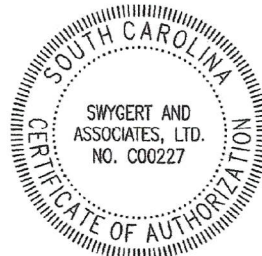
NFPA 13 - 2019 Edition, NFPA 14 - 2019 Edition, NFPA 20 - 2019 Edition

Scope of work (i.e. sprinkler system A.G. from 1'-0" A.F.F., U.G. from tap to 5'-0" outside, etc.) and notes (attach continuation page when necessary):

Above ground work from 1'-0" above finished floor.

## Specifier's Information

Name: Todd F. Swygert, P.E.  
Engineering services provided through a firm: ☒ Yes ☐ No  
Firm name: Swygert & Associates, Ltd.  
Address: Post Office Box 11686  
City: Columbia  
State: South Carolina Zip: 29211  
Phone: 803-791-9300 ext 102 Fax: 803-791-0830  
E-mail: Todd@swygert-associates.com



Certificate of Authorization



Professional Engineer's Seal

Revision No.: 0

Page 1 of 1

Signature: Todd F. Swygert

Date: 12-11-2023



## SECTION 22 00 10 - GENERAL PROVISIONS - PLUMBING

### PART 1 - GENERAL

#### 1.1 SCOPE:

- A. Bids of work covered by each section of these specifications shall be based on the layout and equipment as shown and specified with only such approved substitutions as are allowed. Drawings show general arrangement of piping. Because of the small scale of drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. The contractor shall carefully investigate structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing such fittings, traps, valves, and accessories as may be required to meet such conditions. Where locations make it necessary or desirable from Contractor's standpoint to make changes in arrangements or details shown on drawings, he may present suggestions for such changes and obtain Engineer's approval prior to making such changes.

#### 1.2 CODES:

- A. All work under this division shall be in strict compliance with the International Building Code – 2021 Edition with SC modifications, the International Plumbing Code – 2021 Edition with SC modifications, and all applicable Codes and Regulations of the Authority Having Jurisdiction.

#### 1.3 MATERIAL AND SHOP DRAWINGS:

- A. Use only new materials and the standard product of a single manufacturer for each article of its type unless specifically mentioned otherwise. Materials and workmanship in the case of assembled items shall conform to the latest applicable requirements of ASME, NEC, ASTM, AWWA, NEMA, and ANSI.
- B. Schedule submittals to expedite work. Unless otherwise indicated in this Section, submittals shall be submitted within 30 days of the date of Notice to Proceed. Provide electronic copies of submittals for review and approval. All submittals shall be emailed in a single volume. Partial lists will not be considered and will be returned to the Contractor. Identify Project, Contractor, subcontractor, supplier, manufacturer, pertinent drawing sheet and detail numbers, and associated specification section numbers. Identify variations from requirements of Contract Documents. Any submittal that exceeds 10 MB shall be transferred using Dropbox or other similar file sharing service.
- C. Contractor responsibilities:
  - 1. Review submittals prior to transmittal. Verify compatibility with field conditions and dimensions, product selections and designations, quantities, and conformance of submittal with requirements of Contract Documents. Return non-conforming submittals to prepare for revision rather than submitting to Engineer. Coordinate submittals to avoid conflicts between various items of work. Failure of Contractor to review submittals prior to transmittal to Engineer shall be cause for rejection.

Incomplete, improperly packaged, and submittals from sources other than Contractor will not be accepted. Submittals not stamped APPROVED and signed by the Contractor will be returned to the Contractor.

2. Prepare ¼" per foot scale drawings of the main mechanical room. All equipment submitted shall be of adequate size and physical arrangement to allow unobstructed access when installed, for routine maintenance, coil removal, shaft removal, motor removal and other similar operations. Contract Drawings shall not be reproduced and submitted as shop drawings. Drawings shall be 8-1/2 by 11 inches minimum and 24 by 36 inches maximum. Title each drawing with Project name and reference the sheet the drawing corresponds to.
3. Provide product data such as manufacturer's brochures, catalog pages, illustrations, diagrams, tables, performance charts, and other material which describe appearance, size, attributes, code and standard compliance, ratings, and other product characteristics. Provide all critical information such as reference standards, performance characteristics, capacities, power requirements, wiring and piping diagrams, controls, component parts, finishes, dimensions, and required clearances. Submit only data which are pertinent. Mark each copy of manufacturer's standard printed data to identify products, models, options, and other data pertinent to project.
4. Engineer will review and return submittals with comments. Do not fabricate products or begin work which requires submittals until return of submittal with Engineer acceptance. Promptly report any inability to comply with provisions. Revise and resubmit submittals as required within 15 days of return from Engineer. Make re-submittals under procedures specified for initial submittals. Identify all changes made since previous submittal.

D. Engineer Review:

1. Engineer will review submittals for sole purpose of verifying general conformance with design concept and general compliance with Contract Documents. Approval of submittal by Engineer does not relieve Contractor of responsibility for correcting errors which may exist in submittal or from meeting requirements of Contract Documents. After review, Engineer will return submittals marked as follows to indicate action taken:
2. No Exception: Part of work covered by submittal may proceed provided it complies with requirements of Contract Documents. Final acceptance will depend upon that compliance. The term "approved" shall only indicate that there is no exception taken to the submittal.
3. No Exception As Corrected: Part of work covered by submittal may proceed provided it complies with notations and corrections on submittal and requirements of Contract documents. Final acceptance will depend upon that compliance.

4. Revise And Resubmit: Do not proceed with part of work covered by submittal including purchasing, fabricating, and delivering. Revise or prepare new submittal in accordance with notations and resubmit.

E. Items Requiring Submittal are as Follows:

1. Insulation
2. Piping Materials
3. All items listed in MANUFACTURERS: Section of 22 00 10

1.4 ASBESTOS:

- A. At any time the Contractor encounters asbestos, he shall immediately stop work in the immediate area and suspend any further work until asbestos is removed. Contractor shall, upon discovery of asbestos, notify owner, or owner's representative, who shall be responsible for the removal of the asbestos, all in accordance with NESHAP (National Emission Standard for Hazardous Air Pollutants). Any form of asbestos removal or demolition shall be by owner. Engineer is not an "Owner or Operator" as defined under NESHAP.
- B. Contractor is responsible for, and shall be aware of all state and federal laws pertaining to asbestos as well as NESHAP requirements.

1.5 LEAD FREE:

- A. All solder, flux and pipe used in water system must be lead free. Lead free is defined as less than 0.2 percent lead in solder and flux and less than 8.0 percent lead in pipes and fittings.

1.6 AMERICANS WITH DISABILITIES ACT:

- A. All items or work under this division of the specifications shall comply with guidelines as set forth in the Americans with Disabilities Act.

1.7 PERMITS AND FEES:

- A. Obtain permits, licenses, pay fees, etc. as required for performance of Contract. Arrange for necessary inspections required by governing authority and deliver certificates of approval to Architects or their representatives. File plans required by governing body.

1.8 DEFINITIONS:

- A. In this division of the specifications and accompanying drawings, the following definitions apply:
- B. Provide/Install: To purchase, pay for, transport to the job site, unpack, and connect complete and ready for operation; to include all permits, inspections, equipment, material, labor, hardware, and operations required for completion and operation.

- C. Furnish: To purchase, pay for, and deliver to the job site for installation by others.
- D. The Plumbing Contractor is cautioned that "furnish" requires coordination with others. Such coordination costs shall be included as part of Plumbing Contractor's bid.

1.9 CUTTING AND PATCHING:

- A. Cutting of walls, floors, roofs, partitions, and ceiling, required for proper installation of the systems shall be performed under this contract.
- B. Cutting shall be done in a neat, workmanlike manner. No joists, beams, girders, columns, or other structural members may be cut without written permission from the Engineer. When possible, holes shall be saw-cut, or core drilled neat to minimize patching.
- C. Re-routing of existing pipes, insulation, etc. as required for installation of new system is included in this work. All work shall be done in accordance with specifications for new work of the particular type involved.
- D. Patching shall be performed to match existing structures, exterior walls and roofs, and shall form a watertight installation.

1.10 VERIFICATION OF DIMENSIONS, ETC.:

- A. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work, working conditions, verify all dimensions in the field, advise the Engineer of any discrepancy, and submit shop drawings of any changes he proposes to make for approval before starting the work. The contractor shall install all equipment in a manner to avoid building interference.

1.11 COORDINATION WITH OTHER TRADES:

- A. Coordinate all work of each section with work of other sections to avoid interference. Bidders are cautioned to check their equipment against space available as indicated on drawings, and shall make sure that proposed equipment can be accommodated. Before beginning work under each section, inspect installed work of other trades and verify that such work is complete to the point where the installation may properly begin.

1.12 PROTECTION OF ADJACENT WORK:

- A. Protect work and adjacent work at all times with suitable covering. All damage to work in place caused by Contractor shall be repaired and restored to original good and acceptable condition using same quality and kinds of materials as required matching and finishing with adjacent work.

1.13 FIRESTOPPING:

- A. Provide firestopping for all mechanical penetrations through fire resistant walls and shaft enclosures, and floor, ceiling, and roof elements of fire resistant assemblies. Firestopping shall provide rating comparable to rating of structure it protects.

- B. Firestopping materials currently classified with UL as "Through Penetration Firestop Systems".
- C. Firestopping materials shall have been tested in accordance with UL 1479 "Fire Tests of Through Penetration Firestops".

1.14 CLEAN-UP:

- A. At the completion of the contract work, all areas where work has been performed shall be left clean. All trash shall be removed from the site by the Contractor.

1.15 APPROVALS AND SUBSTITUTIONS:

- A. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such references shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, or type of construction which, in the judgment of the Engineer, expressed in writing, is equal to that specified.
- B. Requests for written approval to substitute materials or equipment considered by the Contractor as equal to those specified, shall be submitted for approval to the Engineer ten (10) days prior to bid date. Requests shall be accompanied by samples, descriptive literature and engineering information as necessary to fully identify and evaluate the product. No increase in the contract sum will be considered when requests are not approved.

1.16 AS-BUILT DRAWINGS:

- A. The Contractor shall keep a record set of drawings on the job; and as construction progresses shall show the actual installed location of all items, material, and equipment on these job drawings. Indicate approved changes in red ink.
- B. At the time of final completion, a corrected set of As-Built drawings shall be delivered to the Engineer. A final set of reproducible drawings with job information that reflects the actual installation shall be prepared by the contractor and given to the Owner.

1.17 WARRANTY:

- A. The Contractor for each section of the work under this division will furnish to the Owner a written warranty for the installation as installed, to perform in a quiet, efficient, and satisfactory manner with no more than normal service.
- B. Each warranty shall extend for a period of one year following substantial completion and acceptance of construction. They shall be endorsed by the Contractor.

1.18 MANUFACTURERS:

- A. In order to define requirements for quality and function of manufactured products, and requirements such as size, gauges, grade selection, color selections and like specifications requirements, the specifications as written hereinafter are based upon products of those manufacturers who are named hereinafter under various specifications for materials.
- B. In addition to products of manufacturers named hereinafter in the specifications, equivalent products of the following named manufacturers will be acceptable under the base bid:
  - 1. Temperature and Air Pressure Gages:
    - a) Dwyer Instruments, Weiss Instruments, H.O. Trerice Company, Ellison Draft Gauge Company, Inc., Weksler Instrument, Ashcroft, Dwyer
  - 2. Insulation:
    - a) Owens Corning, Johns Manville, CertainTeed Corporation, Knauf Insulation
  - 3. Valves:
    - a) Crane Company, Grinnell Company, O.I.C. Valve Co., Chase Brass & Copper Company, Rockwell Manufacturing Company, Consolidated Brass Company, Hammond, Nibco.
  - 4. Pipe Hangers:
    - a) Cooper B-Line, Fee and Mason Manufacturing Company, Anvil International, Erico Caddy, Tolco a Division of Nibco
  - 5. Plumbing Fixtures:
    - a) Kohler Company, American-Standard Plumbing & Heating Division Company, Just Manufacturing Company, Elkay Manufacturing Company, Stern Williams, Fiat, Zurn Industries, Toto USA
  - 6. Showers:
    - a) Aquatic, Comfort Designs, Aqua Bath Company, Bestbath, Sterling
  - 7. Electric Drinking Fountains:
    - a) The Halsey W. Taylor Manufacturing Company, Ebco Manufacturing Company, Haws Drinking Faucet Company, Oasis Mfg. Co., Elkay Manufacturing Company

8. Flush Valves:
  - a) Toto USA, Sloan Valve Company, Coyne & Delany Company, Zurn Industries (PL Model only)
9. Water Closet Seats:
  - a) Church Seat Company, Beneke, Olsonite Corp., Bemis Mfg. Co., Centoco
10. Floor Drains, Roof Drains, Cleanouts, etc.:
  - a) Wade, Inc., Zurn Industries, Inc., Josam Manufacturing Company, Jay R. Smith
11. Emergency Safety Equipment:
  - a) Encon Safety Products, Haws Drinking Faucet Company, Guardian Equipment, Western Emergency Equipment
12. Dielectric Fittings:
  - a) Capitol Manufacturing Company, Dresser Manufacturing Company, Epco Sales, Inc.
13. Water Heating Equipment:
  - a) Cemline, Leslie, Rheem Manufacturing Company, Ruud, State Industries, Lochinvar, A.O. Smith
14. Water Temperature Control Valves:
  - a) Symmons Engineering Company, Lawler Automatic Control, Inc., Powers, Leonard Valve Company
15. Plumbing Trim:
  - a) Delta Commercial Faucet Company, Chicago Faucets, Speakman, T & S Brass and Bronze Works, Inc., Zurn Industries, Symmons Engineering Company, Moen, Kohler Company
16. Recirculating Pumps:
  - a) Bell & Gossett Company, Taco, Inc.
17. Sump Pumps:
  - a) Bell & Gossett Company, Weil, Weinman, Barnes, Liberty Pumps

- 18.     Booster Pumps:
  - a)     Bell & Gossett Company, Taco, Inc., Hy-Fab, SyncroFlo
- 19.     Supplies, Traps, etc.:
  - a)     McGuire Manufacturing Company, Engineered Brass Company, Zurn Industries
- 20.     Automatic Flow Valves:
  - a)     IMI Flow Design, Hays Fluid Company
- 21.     Identification Items:
  - a)     Seton Name Plate Company, W.H. Brady Company, Handley Industries, Inc.

## PART 2 - PRODUCTS

### 2.1     PAINTING:

- A.     Furnish touch up paint supplied by equipment manufacturer.
- B.     Coat ferrous metal surfaces that do not have factory painting or galvanizing with one coat of Sherwin Williams high heat aluminum paint.

### 2.2     CONCRETE EQUIPMENT FOUNDATIONS:

- A.     Use 3000-psi "batch plant" concrete or approved "precast" reinforced concrete foundations.

### 2.3     NAME PLATES:

- A.     All equipment provided under this division shall be labeled with a Bakelite nameplate 1" x 3" minimum with 3/8" minimum height lettering as manufactured by Seton Name Plate Company.

### 2.4     VALVES:

- A.     All valves provided under each section shall be of a single manufacturer unless otherwise specified. Each threaded valve shall have a union installed adjacent to it. All valves shall be of listed manufacturer as scheduled hereinafter in other sections of Division 22.
- B.     Valve handles shall be easily accessible and shall be installed so that stems are horizontal or above except where required for accessibility.



## 2.5 VALVE TAGS AND SCHEDULE:

- A. Provide separate typewritten list of all valves, giving number and use and control of each, on a small scale drawing outlining the general run of pipe lines and showing the location of valves for each section of work. Pipe lines in diagram shall be color coded to match piping. Drawings to be framed under glass and located in the equipment room. Provide a 1-1/2" diameter round brass numbered tag secured to each valve with "S" hook, Style P-250 BL as manufactured by Seton Name Plate Company, Brady Worldwide, Brimar Industries, or equal.

## 2.6 THERMOMETERS FOR PIPING:

- A. Thermometers, except where otherwise specifically noted on drawing, shall be of the red reading liquid in glass column type, or magnified column type with wide angle vision and high magnification of liquid column, equal to Weiss Instruments model 9VU.
- B. All thermometers shall be heavy one-piece cast aluminum construction with 9" scale and glass front. Thermometers shall be accurate within plus or minus one of the smallest scale divisions through the entire range.
- C. Thermometer shall be provided where indicated on the drawings and shall be easily read. Thermometers shall be so selected that normal operating temperature will be in the mid-range of the thermometer. Thermometers shall have a maximum of two degrees between graduations and shall have a maximum of ten degrees between figures.

## 2.7 PRESSURE GAUGES:

- A. Pressure gauges shall be installed as indicated on the drawing. Pressure gauges shall be single spring bourdon tube type with wear resisting moving parts and adjustable linkage. Gauge movement shall be suitable mounted in a cast aluminum case with glass front and plain removable ring.
- B. Each gauge shall be equipped with a brass needle valve.
- C. Gauges shall be installed in such a manner so as to be accessible and easily read. Range of gauge for each particular point of application shall be selected so that pointer is approximately in midpoint of scale under normal operating conditions with maximum readings approximately two times the expected working pressure.

## 2.8 FIRESTOPPING MATERIALS:

- A. The material used to fill the annular space shall prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E 119 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inches of water at the location of the test specimen for the time period equivalent to the fire resistance rating of the construction penetrated. Material shall be capable of curing in the presence of atmospheric moisture to produce durable and flexible seal, and will form airtight and watertight bonds with most common building materials in any combination including cement, masonry, steel, and aluminum.

## 2.9 SLEEVES AND OPENINGS:

- A. Provide UL certified fire stop sleeving system for all pipe penetrations through fire rated walls, floors, partitions, ceilings, floor-ceiling assemblies and roofs as tested under ASTM E814-13a "Standard Method of Fire Tests of Through Penetration Fire Stops".

## 2.10 SEISMIC RESTRAINTS:

- A. Seismic restraints shall be provided per International Building Code Chapter 16 for Category C Buildings.

# PART 3 - EXECUTION

## 3.1 CONCRETE EQUIPMENT FOUNDATIONS:

- A. Consult ASHRAE: A Practical Guide to Seismic Restraint, Chapter 6 for specific reinforcement and anchoring details, with respect to pad size and seismic forces. Unless otherwise noted, set all floor mounted and "on-grade" mounted equipment on 6" high concrete foundation pads. Concrete foundations shall be reinforced with #4 bars - 12" o.c. both ways, or as directed by A Practical Guide to Seismic Restraint. Pads shall be approximately 6" larger than equipment base, and have 1" x 1" chamfer on all edges. Pads shall have carborundum brick rubbed finish. Surface finish shall be uniformly smooth. Concrete floor shall be rough and foundation doweled to floor per A Practical Guide to Seismic Restraint.

## 3.2 EXCAVATION, TRENCHING AND BACKFILLING:

- A. To accommodate mechanical work execute all excavation, trenching, shoring and backfilling in excess of that required for structures. Coordinate this work with that required for structures, and schedule such work to be consistent with other construction work. All work shall be in compliance with OSHA safety standards.
- B. Perform all excavations of every description and whatever substances encountered, to depths indicated, or as otherwise specified. During excavation, material suitable for backfilling shall be piled a sufficient distance from banks of trench in an orderly manner. Avoid overloading to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and wasted as indicated on drawings or as directed. Execute such grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Any water accumulating therein by surface flow, seepage or otherwise, shall be removed by pumping or by other approved method. Such sheeting, bracing and shoring shall be done as may be necessary for protection of work and for safety of personnel. Unless otherwise indicated, excavation shall be by open cut. Short section of a trench may be tunneled if, in the opinion of the Engineer, the pipe can be safely and properly installed and backfill can be properly tamped in such tunnel sections. Excavation shall be considered as unclassified and shall be executed complete.

- C. Width of trenches at any point below top of pipe shall not be greater than outside diameter of pipe plus 16" for pipes measuring up to thirty inches, to permit satisfactory jointing and thorough tamping of bedding material under and around pipe. Care shall be taken not to over-excavate. Correct over-excavation by means of backfilling with concrete, or tamped and compacted suitable backfill material as approved for other backfilling work.
- D. Remove rock in either ledge or boulder formation and replace with selected materials in such manner as to provide a compacted earth cushion having a thickness between unremoved rock and pipe of at least eight inches, or 1/2 inch for each foot of fill over top of pipe, whichever is greater, but not more than three-fourths nominal diameter of pipe. Where bell-and-spigot pipe is used, maintain cushion under bell as well as under straight portion of pipe.
- E. Whenever wet or otherwise unstable soil that is incapable of adequately supporting pipe is encountered in trench bottoms, remove such material to depth required and replace to the proper grade with selected material compacted as hereinafter specified for backfilling of pipe.
- F. Bedding surface for pipe shall provide a firm foundation of uniform density throughout entire length of pipe. Carefully bed pipe in a soil foundation that has been accurately shaped and rounded to conform to lowest one-fourth of outside portion of circular piped, or lower curved position of pipe arch for entire length of pipe or arch. When necessary, tamp bedding firmly. Bell holes and depressions for joints shall be only of such length, depth, and width as required for properly making particular type joint.
- G. Existing utility lines that are shown on drawings, or locations of which are made known to Contractor prior to excavation, and that are to be retained, as well as utility lines constructed during excavation operation shall be protected from damage during excavation and backfilling and, if damaged, shall be repaired by Contractor at his expense. In event that Contractor damages any existing utility lines that are not shown on drawings or locations of which are not know to Contractor, report thereof shall be made immediately. If it is determined that repairs shall be made by Contractor, such repairs will be ordered under terms of "Changes in the Work" as set forth in the General Conditions.
- H. After bedding has been prepared and pipe installed, selected material from excavation or burrow, at a moisture content that will facilitate compaction shall be placed along both sides of pipe in layers not exceeding six inches in compacted depth. Bring backfill up evenly on both sides of pipe for its full length. Care shall be taken to ensure thorough compaction of fill under tampers and rammers. Continue this method of filling and compacting until fill has reached an elevation of at least 12 inches above top of pipe. Backfill and compact remainder of trench by spreading and rolling, or compact by mechanical rammers or tampers in layers not exceeding eight inches.
- I. In compacting by rolling or operating heavy equipment parallel with pipe, displacement of or injury to pipe shall be avoided. Movement of construction machinery over previously installed work at any stage on construction shall be at Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at option of Engineer and expense of Contractor.

- J. Wet down all fill and backfill work, and each layer thereof to obtain optimum moisture content. Compaction shall then be executed to density of 95 percent of that obtainable in laboratory by Procter Method, or by AASHTO Method T99.
- K. When fill or backfill is required to be compacted to any specified density factor, tests shall be executed by an approved laboratory to ascertain compliance with requirements. One test shall be made for each 50 linear feet of open trench. Repeat tests for any specific area which fails to meet requirements until conformance is obtained. Cost of laboratory services shall be borne by Contractor as part of costs for this section of work.
- L. Remove from site all excess earth, rock and other debris resultant from excavation and backfilling work.
- M. When piping penetrates exterior foundation walls, pipe shall be water sealed with foundation using Link Seal, or equal, modular seal elements.

### 3.3 PIPE FITTINGS:

- A. General: Provide complete systems of piping and fittings for all services as indicated. All pipe, valves, and fittings shall comply with American National Standards Institute, Inc. Code and/or local codes and ordinances. All fittings shall be domestically produced from domestic forgings. Cut pipe accurately to measurements established at building or site, and work into place without springing or forcing, properly clearing all windows, doors, and other openings or obstructions.
- B. Excessive cutting or other weakening of building to facilitate piping installation will not be permitted. Piping shall line up flanges and fittings freely and shall have adequate unions and flanges so that all equipment can be disassembled for repairs. Test all piping prior to insulation or concealing.

### 3.4 PIPE:

- A. All piping material shall be as specified in other sections of this division.
- B. Fittings and Connections: All turns and connections shall be made with long radius fittings as scheduled hereinafter.
- C. Pipe joints shall be made in accordance with the following applicable specifications:
- D. Make up flanged joints with ring-type gaskets, 1/16 inch thick.
- E. Make all solder joints with copper and copper alloy press fittings where applicable. Sealing elements for press fittings shall be HNBR.
- F. Cast Iron Pipe: Joints in cast iron soil pipe and fittings without hubs shall be made using cast iron No-Hub joint with "Clamp-All Corporation" clamp, or approved heavy duty four band clamp as manufactured by Husky, or Mission. Coupling shall be tested and certified to ATM C1540.

- G. Plastic Pipe: Joints for polyvinyl chloride pipe and fittings shall be made using solvent cement. Threaded joints shall be used only where required for disconnection and inspection.
- H. Make joints between earthenware fixtures and soil pipe by means of brass floor connections wiped to lead pipe. Joint shall be gas-tight and water-tight. Set all floor type water closets with a "no-seep" sleeve gasket. Caulk around perimeter of all floor mounted plumbing fixtures for leveling and prevention of water seepage.

### 3.5 SLEEVES:

- A. Provide all sleeves in floors, beams, wall, roof, etc. as required for installing work of this division unless otherwise specified hereinafter. Size sleeves for insulated pipe to accommodate both pipe and insulation. Construct vertical sleeves in connection with concealed piping of 22 gauge galvanized iron. Sleeves thru fire-rated assemblies shall be firestopped as specified herein and insulation shall not pass thru sleeve unless material complies with firestopping specified.

### 3.6 PIPE HANGERS, SUPPORTS AND INSERTS:

- A. Pipe hangers, supports and inserts shall comply with Table 308.5 of the 2018 International Plumbing Code and be provided as follows:
- B. All piping shall be supported by forged steel hangers or brackets suitably fastened to structural portion. Wall brackets shall be Fee & Mason Fig. No. 151. Provide lock nuts on all adjustable hanger assemblies.

#### PIPE SIZE - INCHES

	1/2 – 2	2-1/2 – 4	6 – Up	Wall Plate Hanger
Grinnell	104	260	171	139
Fee & Mason	199	239	170	302
Elcen	92	12	15	---

- C. Hanger or Support Spacing (unless specified different hereinafter):

#### 1. Copper Pipe:

Nominal Pipe Size – Inches	Maximum Span - Feet
1-1/4" and under	6'
1-1/2" and above	10'

#### 2. Cast Iron Pipe:

Length of Pipe – Feet	Maximum Span - Feet
5'- 0"	5'

10'- 0"

10'

3. Plastic Pipe:
  - 4'- 0" intervals
- D. Size hangers on insulated piping to permit insulation and saddles to pass full size through hanger.
- E. On Cast Iron Soil Pipe (horizontal):
  1. At least one hanger on each full length of pipe, close to hub where possible and at least one within 24 inches of each fitting, and wherever else required to prevent tendency toward deflection due to load. Hanger at upper angle of each drop. Where multiple fittings are used, hangers shall be located not more than 4 feet on centers and adjacent to hubs on fittings.
- F. On Chromium-plated Pipe:
  1. Provide chromium-plated supports on chromium-plated pipe and fittings.
- G. Bases of Stacks:
  1. If not buried in earth, to be supported on concrete, brick in cement mortar, metal brackets permanently attached to the building structure, or by other approved methods.
- H. Trapeze Hangers:
  1. May be used for groups of pipes close together and parallel. Trapeze hangers may be constructed from structural channel or angle irons or from pre-formed channel shapes. All pipe lines must be held on specific centers by U bolts, clips or clamps.
- I. Inserts:
  1. For each hanger on horizontal pipes, installed before concrete is poured. Inserts shall permit horizontal adjustment of the nut.
- J. Special and Additional Supports:
  1. Special supports will be required where hangers cannot be used. Horizontal pipes shall be secured to prevent vibration or excessive sway. Where pipes must be laid on fill, they shall be supported at each joint by brick or concrete supports carried down into solid, natural earth. Where required, provide additional hangers to secure required level, slope or drainage, and also to prevent sagging. Provide a hanger within one foot of each elbow. Provide all miscellaneous steel required for pipe supports, anchors, etc.

- K. Hangers and other support devices shall be by Grinnell, Unistrut, Fee & Mason, Elcen, Mueller, or Auto-Grip.

3.7 INSULATION SHIELDS:

- A. Provide all insulated piping with 10-inch long (16 gauge) protective galvanized sheet metal shields extending 120 degrees around bottom of insulated pipe at all hangers.

3.8 FLOOR, WALL AND CEILING PLATES:

- A. Where pipes pass through floors, finished walls, or ceilings, fit with chromium plate cast brass plates or chromium plated steel plates as specified hereinafter. Plates shall be large enough to completely close hole around pipes, and shall be square, octagonal, or round, with least dimension not less than 1-1/2 times larger than diameter of pipe. Secure plates in an approved manner. Plates shall be Beaton-Caldwell No. 3A for floors and No. 40 for walls and ceilings.

3.9 SWING CONNECTIONS:

- A. Swing connections shall be provided at all points of expansion. Install all connections to equipment, etc. in a manner to allow for normal pipe movement due to thermal expansion without causing undue stresses to be exerted on said equipment.

3.10 REDUCING FITTINGS:

- A. Where pipe lines reduce in size, provide reducing fittings wherever possible. Provide eccentric fittings or reducers where horizontal runs of supply lines reduce in size, and install so that there will be no air trapped in hot or cold water systems. In screwed work, no bushings shall be used unless there is a difference of two standard pipe sizes between inner and outer threads.

3.11 DIELECTRIC CONNECTIONS:

- A. Wherever any connection is made between dissimilar metals, provide dielectric pipe couplings or unions.

3.12 CLEANING:

- A. All surfaces on metal, pipe, insulation covered surfaces, and other equipment furnished and installed under this division of the specifications shall be thoroughly cleaned of grease, scale, dirt and other foreign material.

3.13 TESTING (PIPING):

- A. Upon completion of each system of work under this division, and at a designated time, all piping shall be pressure tested for leaks in the presence of the owner. Owner shall be notified five days before testing is to be conducted and all tests shall be conducted in the presence of the owner. All equipment required for test shall be furnished by contractor at his expense. All tests shall be performed as specified hereinafter. If inspection or tests show

defects, such defective work or material shall be replaced and inspection and tests repeated at no additional cost to owner. Make tight any leaks. Repeat tests until system is proven tight. Caulking of leaks will not be permitted. All equipment not capable of withstanding the test pressure shall be valved off during the test.

- B. Drainage System: Drainage and venting system shall be tested in such a manner that cast iron soil pipe will not be subjected to excessive pressure. Testing of any portion of this system shall be executed by plugging all necessary openings of that portion of system being tested and filling with water to a height of not less than ten feet above highest floor, or a pump may be used to maintain an equivalent pressure. Test pressure shall be maintained to thirty minutes when using pump method. When using water column method, test period shall also be thirty minutes, and water level shall not drop. Hot poured joints shall not be tested with more than eighty feet head of water. No tests shall be made during freezing weather and all tests shall be made prior to backfilling.
- C. Hot and Cold Water Piping: Upon completion of rough-in and before setting fixtures, entire hot and cold water systems shall be tested at a hydrostatic pressure of 1-1/2 times operating pressure, but not less than 150 psig, and be proved tight at this pressure. Where a portion of water system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system. Water used for testing shall be from a potable source of supply.
- D. Storm drainage piping shall be tested in a manner as specified hereinbefore for drainage system.

### 3.1 IDENTIFICATION OF PIPING:

- A. All piping, bare and insulated in main mechanical room, shall be given two coats of finish painting by this contractor as listed hereinafter. Paint shall be Glidden Industrial Enamel, or equal by Sherwin-Williams or Devoe Paints. Samples of colors and type paint shall be submitted for approval prior to application.

### 3.2 PIPE CODING:

- A. After all piping has been painted with color-coding where applicable, all piping installed under this division, regardless of painting, shall be coded and marked with "Perma-Code" pipe markers as manufactured by W.H. Brady Company, 712 Glendale Avenue, Milwaukee, Wisconsin. Markers shall be applied to properly identify piping, but in no case shall they be applied more than 20 feet apart. Markers shall be 1-1/8 inch by 7 inches and shall be secured by spiral wrapping with 3/4 inch wide vinyl banding tape, color matching service, at each end of marker.

### 3.14 IDENTIFICATION OF EQUIPMENT IN MECHANICAL AREAS:

- A. All items of mechanical equipment shall be identified with a black bakelite label with engraved white lettering 1/2" tall. Labels shall be mechanically attached to the equipment with rivets or stainless steel screws.



3.15 OPERATION AND MAINTENANCE INSTRUCTIONS, AND MAINTENANCE MANUAL:

- A. Upon completion of work, and at a time designated by the engineer, a competent employee of the contractor shall be provided to instruct a representative of the owner in the operation and maintenance of the system.
  - 1. Minimum instruction period shall be:
    - a) Plumbing System - 1/2 day
- B. Maintenance Manuals: The contractor shall compile and bind five (5) sets of all manufacturer's instructions and descriptive literature on all items of equipment furnished under this work. These instructions shall be delivered through the general contractor to the engineer for approval prior to final inspection.
  - 1. Instructions shall include:
    - a) Warranty letter signed by the Mechanical Contractor.
    - b) Index for each section with each section properly identified.
    - c) Copy of sterilization report.
    - d) Copy of backflow preventer test.
    - e) Complete equipment list with model and serial numbers.
    - f) Copy of one complete, approved submittal for each equipment section.
    - g) Description of each system, including manufacturer's literature for all items.
    - h) Start-up and shut-down description for each system.
    - i) Suggested operating and maintenance instructions with frequency of maintenance indicated.
    - j) Parts list for all items of equipment.
    - k) Name, address, and telephone number of nearest sales and service organization for all items of equipment.
- C. Manuals shall be 8-1/2 x 11 inch text pages in digital PDF format. Prepare binder covers with printed subject title of manual, title of project, date, and volume number when multiple binders are required. Provide a table of contents for each volume. Internally subdivide the binder contents with bookmarks providing a link to each section. Provide directory listing as appropriate with names addresses, and telephone numbers of design consultant, Contractor, subcontractors, equipment suppliers, and nearest service representatives.

End of Section 22 00 10

## SECTION 22 05 00 - PLUMBING

### PART 1 - GENERAL

#### 1.1 WORK INCLUDED:

- A. General Requirements: This Section of the Specifications and related drawings describe requirements pertaining to plumbing work including applicable insulation in separate Section 22 07 00. All work shall conform to Section 22 00 10, General Provisions - Plumbing. Work includes, but is not necessarily limited to:
  - 1. All fixtures noted or specified.
  - 2. Cold water and hot water systems.
  - 3. Storm drainage system.
  - 4. Soil, waste and vent piping system.
  - 5. Other plumbing indicated on drawings, specified herein, or required for complete and proper installation in accordance with applicable codes and regulations.
  - 6. Insulation.
- B. Upon completion of work, all fixtures, devices, etc. for use by persons with disabilities shall meet all requirements as set forth by the Americans with Disabilities Act (ADA).

### PART 2 - PRODUCTS

#### 2.1 SOIL, WASTE, DRAIN AND VENT PIPING AND FITTINGS:

- A. Materials shall conform to the following specifications requirements:
- B. Construct all building sewers and building drain lines underground and/or under floor slabs to a point 5'-0" outside of building walls, unless indicated otherwise on the drawings, with Schedule 40 solid wall PVC pipe and fittings by Charlotte, or approved equal. Pipe and fittings shall be manufactured from rigid polyvinyl chloride vinyl compounds with a cell class of 12454 as identified in ASTM D 1784. Piping shall conform to ASTM D1785 and ASTM D 2665. Pipe and fittings shall conform to NSF International Standard 14. Co-ex or foam core piping will not be permitted.
- C. Construct all soil, drain and waste piping, that is installed above floor slabs on Levels 0 and 1 with standard weight, asphaltum-coated, cast iron, bell-and-spigot type, soil pipe and fittings. Pipe and fittings shall be labeled with the Cast Iron Soil Pipe Institute's Collective Trademark of quality and permanence as illustrated in ASTM Standard A-74, which indicates that it complies with this standard. No import pipe will be allowed. At the base

of stacks and 90 degree bends not located in the ground, contractor shall install a Holdrite, or equal, #117-LS (long sweep) Series No-hub restraint.

- D. Construct all soil, drain and waste piping, that is installed above floor slabs on Levels 2 through 10 with Schedule 40 solid wall PVC pipe and fittings by Charlotte, or approved equal. Pipe and fittings shall be manufactured from rigid polyvinyl chloride vinyl compounds with a cell class of 12454 as identified in ASTM D 1784. Piping shall conform to ASTM D1785 and ASTM D 2665. Pipe and fittings shall conform to NSF International Standard 14. Co-ex or foam core piping will not be permitted. PVC piping shall be protected by a steel strike plate of no less than 0.0575 inches when the piping is located within 1-1/4" of the structural members. Strike plate shall extend no less than 2" above and below the structural member.
- E. The Plumbing Contractor will connect soil and storm pipe at a point five feet outside the building.
- F. Construct vent piping on Levels 0 and 1 with standard weight, asphaltum-coated, cast iron, bell-and-spigot type, soil pipe and fittings. Pipe and fittings shall be labeled with the Cast Iron Soil Pipe Institute's Collective Trademark of quality and permanence as illustrated in ASTM Standard A-74, which indicates that it complies with this standard. No import pipe will be allowed.
- G. Construct vent piping on Levels 2 through 10 with Schedule 40 solid wall PVC pipe and fittings by Charlotte, or approved equal. Pipe and fittings shall be manufactured from rigid polyvinyl chloride vinyl compounds with a cell class of 12454 as identified in ASTM D 1784. Piping shall conform to ASTM D1785 and ASTM D 2665. Pipe and fittings shall conform to NSF International Standard 14. Co-ex or foam core piping will not be permitted. PVC piping shall be protected by a steel strike plate of no less than 0.0575 inches when the piping is located within 1-1/4" of the structural members. Strike plate shall extend no less than 2" above and below the structural member.
- H. (OPTION) In lieu of steel or bell and spigot pipe, contractor may use the cast iron No-Hub joint with "Clamp-All Corp." clamp, or approved heavy duty four band clamp as manufactured by Husky, or Mission. Coupling shall be tested and certified to ASTM C1540.

## 2.2 SUPPLY PIPING AND FITTINGS:

- A. Materials for supply piping and fittings shall conform to the following specification requirements:
- B. All domestic water main 3 inches and smaller buried in earth and/or below slabs shall be seamless hard drawn type K copper tubing, ASTM B 88, with wrought copper ASA B16.22 fittings, Class 150.
- C. All water piping aboveground may be Viega, or equal, ProPress G fittings installed in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting on the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully

engaged in the fitting. The joints shall be pressed using the tool approved by the manufacturer. Piping shall be protected by a steel strike plate of no less than 0.0575 inches when the piping is located within 1-1/4" of the structural members. Strike plate shall extend no less than 2" above and below the structural member.

- D. Valves: Materials for valves shall conform to the following specification requirements:
1. Gate:
    - a) Valves 4 inches and larger shall be flanged of non-rising stem iron body, bronze trim, solid wedge type for a minimum working pressure of 200 psig.
  2. Ball:
    - a) Ball valves 3" and smaller shall be two-piece bronze body, full port, chrome ball, RTFE seats, with adjustable packing, rated for 600 psig minimum working pressure, meeting WWV-35 and MSS-SP110.
  3. Check:
    - a) Valves 2 inches and smaller shall be of swing check, solder end type suitable for a minimum working pressure of 300 psig.
    - b) Valves 2-1/2 inches and larger shall be swing check iron body, bronze trim, renewable seat and disc for a minimum working pressure of 200 psig.
- E. Hose Bibb: Interior hose bibbs shall be on angle pattern for 3/4- inch hose connection with rough nickel plate finish Woodford, or equal, Model 27 or B27 as specified. Loose key type shall be provided where indicated.
- F. Wall hydrants shall be Woodford Manufacturing Co., Jay R. Smith, Zurn Industries, or equal, Style 67.
- G. Temperature and pressure relief valves shall be type N 40 XL as manufactured by Watts Regulator Company, Cash Acme, Conbraco, or equal.
- H. Water pressure reducing valve shall be a Watts, or equal, Series LF U5B. The valve shall be constructed using lead free materials and shall have copper inlet and outlets. Valve shall be suitable for water supply pressures up to 300 psi and shall be capable of being adjusted down to 25-75 psi.

## 2.3 CLEANOUTS:

- A. Provide cleanouts as follows:
1. Unfinished areas and chases - Z-1450-7 C.I. cleanout ferrule with counter-sunk lead seal plug.

2. Finished walls - ZN-1440-4 C.I. wall cleanout ferrule with raised head lead seal plug and Nikaloy square scoriated frame and cover.
3. Finished linoleum, asphalt, or vinyl tile floor - ZN-1400-6 C.I. floor cleanout with seriated cut-off ferrule lead seal plug adjustable Nikaloy round scoriated frame and cover recessed for tile.
4. General use in Finished Floor - ZN-1400-4 C.I. floor cleanout with seriated cut-off ferrule lead seal plug adjustable Nikaloy square scoriated frame and cover.
5. All cleanouts shall be manufactured by Zurn Industries, Inc., Jay R. Smith, Josam, or equal.

#### 2.4 DRAINS:

- A. Provide floor drains of manufacturer's standard size at locations indicated on drawings. Construct drains of cast iron with polished brass strainer. Floor drains shall be as indicated on the drawings. Drains shall be manufactured by Zurn Industries, Inc., Jay R. Smith, Josam, or equal.

#### 2.5 ELECTRIC WATER HEATERS:

- A. Provide electric water heaters complete, including all piping, specialties and connections as indicated on the drawings. All water heaters shall meet the minimum energy factor required by the U.S. Federal "National Appliance Energy Conservation Act of 2010".

#### 2.6 STEAM WATER HEATERS:

- A. Cemline, or equal, Model FFH 75 low pressure steam water heaters, for use on 15 psig steam consisting of an integrally piped heat exchanger, mounted on a heavy-duty angle iron frame heater control package capable of supplying 70 GPM of hot water when heated from 40 deg. F to 140 deg. F without the use of thermostatic control devices or storage tanks. Heaters shall be capable of maintaining the +/- 3 deg. F over a flow range of a few percent to 100%. The water shall flow through the tubes and steam in the shell. The heater shall be supplied with main and drip trap, main and drip strainer, dial thermometer, and steam pressure gauge. The unit shall include connections in the manifolds to measure pressures and temperatures.
- B. Cemline FFH steam fired water heater shall be factory piped with main and drip steam traps, main and drip strainers, dial thermometer, and steam pressure gauge. The heater and components shall be mounted on angle iron frame and shall be shipped complete from factory, so owner need only connect steam, condensate outlet, cold water inlet and hot water outlet pipes to the package.
- C. Complete package to be pressure tested for leaks.
- D. Unit to be assembled so that is sufficient room between heat exchanger and traps for proper operation.

E. Options:

- a) The heater shall be equipped with an integral recirculation system with an adjustable valve to set the recirculation temperature. The recirculation system shall be integrally mounted and shall not alter the overall dimensions of the heater.
- b) The heater shall be provided with a pilot operated pressure reducing valve (PRV) to be piped in the field upstream of the FFH heater. The PRV will reduce the steam pressure to 15 psig going to the FFH.
- c) The unit shall be supplied with insulation cover.

2.7 FIXTURES AND FIXTURE TRIM:

- A. Fixtures and fixture trim shall be as called for in the fixture schedule shown on drawings. All enamel on cast iron fixtures shall be acid resisting. The color of fixtures shall be white. All fixtures shall be WaterSense compliant.

2.8 BACKFLOW PREVENTERS:

- A. Provide all backflow preventers in accordance with the requirements of the South Carolina State Board of Health. The backflow preventer for domestic water service shall be a Watts, or equal, Model 909NRS-S reduced pressure zone backflow preventer assembly with non-rising stem shutoff valves and strainer. Backflow preventers shall be lead free and suitable for supply pressures up to 175 psi and water temperatures to 110°F. Provide with bypass. Backflow preventers shall be manufactured by Watts Industries, Zurn Wilkins, Conbraco, or equal.
- B. Upon completion of installation, the contractor shall test all backflow preventers in accordance with the requirements of SCDHEC Regulations, and send a copy of this test report to the engineer and include a copy in the closeout documents.

2.9 STORM DRAINAGE:

- A. All pipes shall conform to sizes shown on drawings. All drain piping shall be similar to that specified for waste and soil piping.

2.10 SHOCK ABSORBERS:

- A. Provide sealed air chambers of PDI size models as indicated and as manufactured by Sioux Chief Model Hydrarester, or equal by Jay R. Smith, Zurn, or Josam. All shock absorbers shall bear PDI seal of approval and tested and certified in accordance with the Plumbing and Drainage Institute "Standard P.D.I. WH-201" and shall not require access.

2.11 AUTOMATIC FLOW VALVES:

- A. Automatic Flow Valves shall be by IMI Flow Design, or approved equal, Model NSF 61-G 3/4" size for flow rates indicated on the plans. Valve shall be constructed with stainless steel.

2.12 PRESSURE BOOSTER SYSTEM:

- A. Furnish and install as shown on the plans a Hy-Fab, or approved equal, Model MVP-D07J Duplex Variable Speed Pressure Booster System.
- B. The Pressure Booster shall provide 250 GPM at a discharge pressure of 110 PSI when supplied with a suction pressure of 80 PSI. Required Boost: 30 PSIG
- C. Pumps shall have the following duty points:
  - Pump 1: 200 GPM @ 30 psi; 10 HP @ 3500 RPM
  - Pump 2: 200 GPM @ 30 psi; 10 HP @ 3500 RPM
- D. Incoming electrical power shall be 208/3/60. Contractor to verify prior to submittal / order process. SCCR rating shall be 20,000.
- E. The unit shall be constructed with 6" type L copper headers. Unit shall be rated for 150 psig working pressure. Headers shall be constructed to be easily removed to allow for service access and moving the unit through 36" doorways.
- F. The unit shall be complete with close coupled, end suction, vertically mounted bronze fitted pumps. Pumps shall be rated for a minimum of 175 psig working pressure. Casings shall have gauge ports and vent and drain ports at top and bottom of casing. Motors shall meet NEMA specifications and shall be of the size, voltage, and enclosure called for on the plans. The pump manufacturer will be one in the same as the pressure booster manufacturer to ensure single unit source responsibility. The manufacturer will have in place a quality assurance program and shall be ISO 9001 certified.
- G. A check valve shall be installed on the lead pump with dedicated variable speed capability. A globe pattern, in-line combination pressure reducing (PRV) and check valve assembly shall be installed on each lag pump discharge. The valve shall have an epoxy coated body with a bronze disc. The valve pilot shall be a direct acting, adjustable, spring-loaded, normally open diaphragm valve. Isolation valves shall be provided for each pump/PRV set. Pressure gages shall be installed on the suction and discharge headers. Pumps shall be protected from thermal buildup, when running at no-flow, by a common thermal relief header.
- H. Pump Logic Controller
  - 1. The Pump Logic Controller shall be provided and is to be complete including main disconnect, variable speed pump controller, pressure transducers, instrumentation and controls to automatically start, stop and modulate pump speed to smoothly, efficiently and reliably provide pump variable flow rates at a constant discharge pressure. The booster package shall include full pump, motor and drive safety features required to protect the equipment and piping system.
  - 2. The pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory, Inc. (UL) and Canadian Underwriter's Laboratory

(CUL). The controller shall be specifically designed for mixing variable and constant speed pumps for pressure boosting applications.

3. The controller shall function to a proven program that safeguards against damaging hydraulic conditions including:
  - a) Pump flow surges
  - b) Hunting
  - c) System over pressure
4. The pump logic controller shall be microcomputer based and hold its software in EPROM. On-line field modified data entries, such as setpoint, shall be stored in EEPROM. EEPROM memory storage shall prevent accidental loss of data due to voltage surge or spike. In the event of a complete power outage, all factory preset values remain stored and shall be able to be recalled by the operator.
5. The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor / transmitters. It will then select the analog signal that has deviated the greatest amount from its setpoint. This selected signal will be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling up to three pumps in parallel.
6. The pump logic controller shall have an additional analog input for a flow sensor.
7. The scan and compare rate that selects the command setpoint and process variable signal shall be continuous and automatically set for optimum operation. Each sensor shall be scanned every 20 milliseconds.
8. All external transmitters shall be powered by the pump logic controller through a quality integral 24 volt power supply. Overvoltage and short circuit protection shall be on board.
9. The hydraulic stabilization program shall utilize a proportional integral derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.
10. The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:
  - a) Multi-fault memory and recall
  - b) Red fault light, yellow warning light, and green power on light.
  - c) Soft-touch membrane keypad switches.
11. The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.
12. The pump controller will vary the speed of the lead pump to maintain set point. If the set point cannot be satisfied by the variable speed pump alone, the pump logic



controller will initiate a timed sequence of events to stage on the constant speed lag pump(s) as needed.

13. Upon decrease in building load when fewer pumps are required to meet set point, the pump logic controller will initiate a timed sequence of events to de-stage the constant speed lag pump(s). The pump controller will then vary the speed of the lead pump to maintain the set point.
14. Alternation of the lag pumps is both manual via keypad and automatic based on running hours.
15. Controller shall be capable of performing the following pressure booster functions:
  - a) Low suction pressure cut-out to protect the pumps against operating with insufficient suction pressure.
  - b) High system pressure cut-out to protect the piping system against high pressure conditions.
  - c) No Flow Shut Down to turn the pumps off automatically when system demand is low enough to be supplied by the hydropneumatic tank. No Flow Shutdown shall not require any external flow meters, flow switches, or pressure switches to determine when a No Flow condition exists.
16. The following communication features shall be provided to the BAS:
  - a) Remote system start / stop non-powered digital input
  - b) Failure of any system component. Output closes to indicate alarm condition.
  - c) One 4-20 mA output with selectable output of:
    - i. Lead Pump Frequency
    - ii. Process Variable

I. Sensor / Transmitter

1. Rosemount 0-150 PSI remote mounted transmitter. The plumbing contractor shall be responsible for wiring of the remote sensor / transmitter from a location out in the system and tied back to the pump logic controller per the manufacturer's instruction and as determined by the Plumbing Engineer. As an option, the contractor may employ the services of a controls contractor to provide the wiring as discussed above.

J. Hydro-Pneumatic Tank:

1. Wessels, or equal, Model FXA-200 53 Gallon ASME Potable Water Storage Tank. (Shipped Loose for Contractor Installation)

2.13 AUTOMATIC FLOW VALVES:

- A. Automatic Flow Valves shall be by IMI Flow Design, or approved equal, Model NSF 61-G 3/4" size for flow rates indicated on the plans. Valve shall be constructed with stainless steel.

2.14 RECIRCULATING PUMPS:

- A. Recirculating pumps shall be Bell & Gossett, or approved equal, of high efficiency models indicated on drawings. Pumps shall be of a horizontal, permanently lubricated type for quiet operation. The motor shall be non-overloading at any point of the pump performance curve.

2.15 SUMP PUMP:

- A. Sump pump shall be Bell & Gossett, or approved equal, of high efficiency models indicated on drawings. Package shall consist of a wastewater pump, fiberglass sump pit, completely assembled with valves, piping, guide rails, and lifting cable. Pump shall be for continuous operation when fully submerged and shall be capable of handling solids up to ½" sphere, and include a float switch. See schedule for operating conditions.
- B. The level controls shall be a sensing device to accurately monitor the liquid levels. The float cable shall be in a water resistant jacket. Control panel shall be standard series with a Nema 4x enclosure with 115 volt control circuit. Panel shall be complete with Hand-Off-Auto switch, high level alarm, solid state printed circuit board with float indicator lights and shall be UL listed.

2.16 MECHANICAL SEAL AND SLEEVES:

- A. All pipes through exterior foundation walls shall have molded non-metalling high density polyethylene sleeves with integral hollow, molded water stop ring four inches larger than the outside diameter of the sleeve. End caps and reinforcing ribs shall be domestically manufactured in an approved ISO-9001 facility. Seals shall be Century Line Sleeve, or equal.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS:

- A. Verify locations and inverts of existing and proposed pipes, location of structural elements, locations and sizes of chases, type and method of construction of floors, walls, partitions, etc.
- B. Drawings do not indicate all offsets, fittings, and specialties. Examine other drawings, investigate conditions to be encountered and arrange work accordingly, furnishing required fittings, valves, specialties, etc. without extra charge. Where conditions necessitate rearrangement, submit for approval sketches showing proposed arrangement.

3.2 INSTALLATION:

- A. GENERAL:
  - 1. Protect pipe openings and drains by plugs or caps. Duct tape will not be acceptable. Clean all stoppages.

2. Unless otherwise shown, install piping concealed, straight, without sags or pockets and graded for drainage. Cut pipe ends square and ream. Before assembly, clean dirt, scale and chips.
3. Provide clearance between pipe and building structure so pipes can expand without damage to building structure.
4. Schedule meetings with other trades before and during installation to avoid conflicts and ensure that pipes and equipment are installed in best manner, taking into consideration headroom, maintenance, appearance and replacement.

### 3.3 PAINTING:

- A. Clean damaged factory finishes and coat with matching touch-up paint. Paint all supports and hangers with two coats of high heat aluminum paint.

### 3.4 SOIL, WASTE, SEWER AND VENT PIPING:

- A. Install sewer and water pipes in separate trenches with grades uniform to provide solid bearing. Dig bell holes at hubs. Piping through or under footings shall be provided with a pipe sleeve or relieving arch.
- B. Run horizontal pipe, graded uniformly, not less than 1/4" per foot for pipes 2-1/2" and smaller; and 1/8" per foot for larger pipes. Offset as required to pass obstacles.
- C. Change size by reducing fittings. Change directions by 45-degree wyes and long-sweep bends. Use short sweep bends only with written approval. No pipe shall be drilled, tapped, or welded. Saddle hubs and bands, tapped tees, and crosses will not be approved.
- D. Upon completion of tests and inspections, backfill with approved material, placed and tamped to prevent settlement.

### 3.5 HOT AND COLD WATER PIPING:

- A. Unless otherwise indicated, run hot and cold water piping concealed, and uniformly pitched to ensure venting and drainage. Install drain valves at low points.
- B. Unless otherwise required, branches to small fixtures shall be 1/2" ID for single fixture and 3/4" ID for two fixtures. Pipe size indications are "nominal" sizes.

### 3.6 STORM DRAINAGE:

- A. This work in general consists of drainage lines, roof drains, downspout nozzles, other structures and connections into storm system at locations as indicated on drawings.

3.7 AIR CHAMBERS:

- A. At each flush valve and other quick closing valves not protected by a shock arrestor, and at top of each hot and cold-water riser, provide a 12-inch long air chamber.

3.8 SHOCK ABSORBERS:

- A. All shock absorbers shall bear PDI seal of approval. Locate shock absorbers as indicated on plans. Install in an upright position

3.9 TRAPS:

- A. Provide each fixture with a trap when connection to drainage system is required. Place each trap as near to the fixture as possible. No fixture shall be double trapped.

3.10 FLASHING:

- A. Vent pipes and stack vents shall be flashed and made watertight at roof with 16 ounce, soft, sheet copper or 4-pound sheet lead. Flashings shall extend not less than 8 inches from pipe in all directions. Flashing for pipe shall be extended up the pipe a minimum of 6 inches, at which point threaded standard cast iron or malleable iron recess roof coupling shall be installed to form counterflashing or rain guard.

3.11 CLEANOUTS:

- A. Provide an easily accessible cleanout at the foot of each vertical soil or waste stack and where indicated on the drawings. Cleanouts shall be of the same nominal size as the pipe in which they are installed, up to 4 inches; and not less than 4 inches for larger sizes. A cleanout shall consist of a long sweep 1/4 bend or one or two 1/8 bends. The maximum spacing of cleanouts shall be one hundred feet. No cleanout shall be closer than 12" to any fixed item to allow for maintenance.

3.12 DRAINS:

- A. Provide floor drains of manufacturer's standard size at locations indicated on drawings. Carefully set drains to grade to provide drainage of surrounding area and trap.

3.13 FIXTURES AND FIXTURE TRIM:

- A. Provide lavatories with angle stops. Provide all other plumbing fixtures with either angle or straight stops, integral with faucets, or with concealed type lock shield or loose-key pattern.
- B. All fixtures and trimmings shall be designed to prevent backflow of polluted water or waste into the water supply system.
- C. Except where noted otherwise, exposed piping fittings and trimmings shall be chromium plated over nickel-plated brass with polished, bright surfaces.

- D. Securely support fixtures with approved brackets, chairs, bolts, and metal expansion inserts. Where chases are provided or adjacent space in an undeveloped area, use through-bolts and heavy steel load distributing plate in addition to other means specified.

3.14 STERILIZATION:

- A. All water piping installed under this section shall be thoroughly sterilized. The entire sterilization procedure shall be in strict accordance with the requirements of the State Board of Health and, upon completion of the sterilization; the potability of the water in the system shall be checked and approved by the Engineer. All costs for testing shall be paid for by this Contractor.

End of Section 22 05 00

## SECTION 22 07 00 – PLUMBING INSULATION

### PART 1 - GENERAL

#### 1.1 WORK INCLUDED:

- A. General Requirements: This section shall include all insulation as required for installation on all items as specified hereinafter and/or as indicated. All insulations shall be installed in a workmanlike manner by qualified workers in the employment of an independent insulation contractor. Costs of insulation shall be included as part of work by contractor as applicable to his section of work. No separate bid is to be included for insulation work.
- B. Fire hazard classification for all material shall not exceed flame spread of 25 and smoke development of 50 as classified by Underwriters Laboratories under Test Method ASTM E-84 and acceptable under NFPA Standards. This is to apply to the complete system and be a composite rating of insulation material with jacket or facings, vapor barrier, joint sealing tapes, mastic, and fittings.
- C. Prior to commencing any work, submit data sheets for engineer's approval of all material proposed to be used on this project.

### PART 2 - PRODUCTS

#### 2.1 ABOVE GROUND INDOOR PIPING:

- A. Pipe Insulation:
  - 1. All water piping shall be insulated with heavy density fiberglass with all-service jacket Owens-Corning Double Self-Sealing Lap, ASJ/SSL-II, one piece, to be used on all lines above and below ambient temperature from 0°F to 850°F.

#### 2.2 JACKET FOR EQUIPMENT ROOM PIPING:

- A. All insulated piping in equipment rooms shall be covered with eight (8) ounce cotton canvas manufactured in the United States. All hot water piping shall be lagged with Childers CP-9, CP-10 or CP-11 Weather Barrier Coating, or equal per Section 15010. All chilled water piping shall be lagged with Childers CP-30 LO Solvent thinned Vapor Barrier Coating or CP-35 Water Based Vapor Barrier Coating, or equal per Section 22 00 10.

#### 2.3 PIPE INSULATION THICKNESS:

- A. Piping for the following systems shall be insulated to the thickness listed:

<u>Item</u>	<u>Insulation Thickness (Inches)</u>
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Fiberglass  
K = .24

Cold Pipes:

Cold Water (Domestic)	1/2"
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Storm Drainage (Horizontal & Vertical to Roof Drain)	1"
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Hot Pipes:

Hot Water (Domestic - Supply & Recirculating)	1"
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### PART 3 - EXECUTION

#### 3.1 PIPE INSULATION:

- A. All insulation shall be applied to clean, dry surfaces butting all sections firmly together and finishing as specified hereinafter.
- B. All vapor barriers shall be sealed, and shall be continuous throughout. No staples shall be used on any vapor barrier jacket unless sealed with vapor barrier coating or vapor barrier tape.
- C. Insulation of all insulated lines shall be interpreted as including all pipe, valves, fittings and specialties comprising the lines.
- D. Where sectional insulation is not practical, the proper insulation cement or block insulation shall be utilized by forming it to the applied surface.
- E. Insulation over fittings and soil pipe hubs shall be of equal thickness as the adjoining pipe insulation. Insulate p-trap's serving ice machines and air handling unit condensate drains where located above slab similar to that specified before for domestic cold water piping.
- F. Pipe Insulation Protection: Direct contact between pipe and hangers shall be avoided. Hanger shall pass outside of a sheet metal protection saddle which shall cover a section of high density insulation (cellular glass or calcium silicate), of sufficient length to support the weight of the pipe without crushing the insulation. The vapor barrier shall be continuous behind the saddle or shall be lapped over the saddle and securely cemented thereto.
- G. All pipe covering shall be furnished with self-seal lap and 3" wide butt joint strips. The release paper is pulled from adhesive edge, pipe covering closed tightly around pipe and self-seal lap rubbed hard in place with the blunt edge of an insulation knife. This procedure applied to longitudinal as well as circumferential joints. Staple all longitudinal and

circumferential joints with 9/16" staples 6" on center and seal over all staples with Childers CP-30 vapor barrier coating. Care shall be taken to keep jacket clean as it is the finish on all exposed work. All adjoining insulation sections shall be firmly butted together before butt joint strip is applied, and all cold water service lines shall have vapor barrier coating thoroughly coated to pipe at butt joints and at all fittings.

- H. To the hot insulated fittings, apply a tack coat of Childers CP-10 or CP-11 (use CP-35 on cold piping) at the rate of 2 gallons per 100 S.F. While the tack coat is still wet, a layer of 10 x 10 fiberglass reinforcing mesh shall be embedded with all fabric seams overlapped a minimum of 2". A finish coat, at a coverage rate of 4 gallons per 100 S.F. shall be applied, fully covering the reinforcing mesh.
- I. Apply fiberglass inserts to all other hot fittings and cold water fittings in conjunction with Proto PVC Fitting Covers. Seal cold applications as recommended by the manufacturer.

End of Section 22 07 00



## SECTION 220800 - COMMISSIONING OF SERVICE WATER HEATING SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes commissioning process requirements for Service Water Heating Systems, assemblies, and equipment.
- B. Related Sections: Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

#### 1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Service Water Heating Systems: Service Water Heating Equipment, Pressure Regulating Devices, Mixing Valves, Piping, Insulation, Pumps, Variable Speed Drives, Controls, Interlocks, Interfaces, Safeties, Accessories and Appurtenances.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Pre-Functional Test Checklists and Equipment Start up Reports

#### 1.5 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Attend testing, adjusting, and balancing review and coordination meetings.
- D. Participate in the commissioning of Service Water Heating Systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices, calibrated within one year of date of test unless specifications or industry standards require more stringent calibration periods, to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

#### 1.6 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Service Water Heating Systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Organize Contractor provided test data, inspection reports, and certificates in Systems Manual.

#### 1.7 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
  - 1. Plan for delivery and review of submittals, operation and maintenance manuals, and other documents and reports.
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Service Water Heating Systems, assemblies, equipment, and components to be verified and tested.
  - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  - 5. Certificate of readiness certifying that Service Water Heating Systems, subsystems, equipment, and associated controls are ready for testing.
  - 6. Test and inspection reports and certificates.
  - 7. Corrective action documents.
  - 8. Verification of testing, adjusting, and balancing reports.

#### PART 2 - PRODUCTS (Not Used)

#### PART 3 - EXECUTION

##### 3.1 TESTING PREPARATION

- A. Provide a fully executed Certificate of Readiness signed by Contractor, Subcontractors, TAB Agent and BAS provider certifying that Service Water Heating Systems, instrumentation and control systems have been completed and calibrated, pre-tested and inspected and that they are operating according to the Contract Documents, and that pretest set points have been recorded. Provide completed Certificate of Readiness to CxA no less than 7 days prior to the scheduled beginning of on-site CxA verification testing.

- B. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- C. Inspect and verify the position of each device and interlock identified on checklists.
- D. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 30 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of Service Water Systems at the direction of the CxA.
- D. The CxA will notify Service Water Heating testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
  - 1. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 2. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
  - 3. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

### 3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Service Water Systems testing shall include entire Service Water Heating Systems installation, from central equipment for heat generation through distribution systems to each water outlet and device.
- C. Testing of systems and equipment shall include measuring capacities and effectiveness of operational and control functions, in addition to, or in conjunction with any statutory and regulatory testing required by Authorities Having Jurisdiction over the project and testing required in other Sections of this Project Manual.
- D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- E. The CxA along with the Service Water Heating Systems Subcontractor shall prepare detailed testing plans, procedures, and checklists for Service Water Heating Systems, subsystems, and equipment.
- F. Tests will be performed using design conditions whenever possible.
- G. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

- H. The CxA may direct that set points be altered when simulating conditions is not practical.
- I. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- J. If tests cannot be completed because of a deficiency outside the scope of the Service Water Heating Systems system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

**END OF SECTION 220800**

## SECTION 23 00 10 - GENERAL PROVISIONS - HVAC

### PART 1 – GENERAL

#### 1.1 SCOPE:

- A. Bids of work covered by each section of these specifications shall be based on the layout and equipment as shown and specified with only such approved substitutions as are allowed. Drawings show general arrangement of ductwork and piping. Because of small scale of drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Contractor shall carefully investigate structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing such fittings, traps, valves, and accessories as may be required to meet such conditions. Where locations make it necessary or desirable from Contractor's standpoint to make changes in arrangements or details shown on drawings, he may present suggestions for such changes and obtain Engineer's approval prior to making such changes.

#### 1.2 CODES:

- A. All work under this division shall be in strict compliance with "International Codes" and all applicable Codes and Regulations of the Authority Having Jurisdiction.

#### 1.3 MATERIAL AND SHOP DRAWINGS:

- A. Use only new materials and the standard product of a single manufacturer for each article of its type unless specifically mentioned otherwise. Materials and workmanship in the case of assembled items shall conform to the latest applicable requirements of NFPA, ASME, NEC, ASTM, AWWA, NEMA, and ANSI.
- B. Schedule submittals to expedite work. Unless otherwise indicated in this Section, submittals shall be submitted within 30 days of date of Notice to Proceed. Provide electronic copies of submittals in PDF format for review and approval. All submittals shall be bound in a single volume. Partial lists will not be considered and will be returned to the Contractor. Controls may be submitted separately and shall be submitted no later than 60 days of notice to proceed. Identify Project, Contractor, subcontractor, supplier, manufacturer, pertinent drawing sheet and detail numbers, and associated specification section numbers. A table of contents shall be included in the front of the submittal with tabs indicating each section. Identify variations from requirements of Contract Documents.
- C. Contractor responsibilities:
  - 1. Review submittals prior to transmittal. Verify compatibility with field conditions and dimensions, product selections and designations, quantities, and conformance of submittal with requirements of Contract Documents. Return non-conforming submittals to preparer for revision rather than submitting to Engineer. Coordinate submittals to avoid conflicts between various items of work. Failure of Contractor to review submittals prior to transmittal to Engineer shall be cause for rejection. Incomplete, improperly packaged, and submittals from sources other than

Contractor will not be accepted. Submittals not stamped APPROVED and signed by the Contractor will be returned to the Contractor.

2. Where required by specifications or otherwise needed, prepare drawings illustrating portion of work for use in fabricating, interfacing with other work, and installing products. Prepare 1/4" per foot scale drawings of all mechanical rooms when substituting items of equipment that are not the basis for design. All equipment submitted shall be of adequate size and physical arrangement to allow unobstructed access when installed, for routine maintenance, coil removal, shaft removal, motor removal and other similar operations. Contract Drawings shall not be reproduced and submitted as shop drawings. Drawings shall be 8-1/2 by 11 inches minimum and 24 by 36 inches maximum. Title each drawing with Project name and reference the sheet the drawing corresponds to.
3. Provide product data such as manufacturer's brochures, catalog pages, illustrations, diagrams, tables, performance charts, and other material which describe appearance, size, attributes, code and standard compliance, ratings, and other product characteristics. Provide all critical information such as reference standards, performance characteristics, capacities, power requirements, wiring and piping diagrams, controls, component parts, finishes, dimensions, and required clearances. Submit only data which are pertinent. Mark each copy of manufacturer's standard printed data to identify products, models, options, and other data pertinent to project.
4. Control diagrams: Show relative positions of each component as a system diagram. Provide points list, wiring diagram and schedule of all products and components used in system.
5. Engineer will review and return submittals with comments. Do not fabricate products or begin work which requires submittals until return of submittal with Engineer acceptance. Promptly report any inability to comply with provisions. Revise and resubmit submittals as required within 15 days of return from Engineer. Make re-submittals under procedures specified for initial submittals. Identify all changes made since previous submittal.

D. Engineer Review:

1. Engineer will review submittals for sole purpose of verifying general conformance with design concept and general compliance with Contract Documents. Approval of submittal by Engineer does not relieve Contractor of responsibility for correcting errors which may exist in submittal or from meeting requirements of Contract Documents. After review, Engineer will return submittals marked as follows to indicate action taken:
2. No Exception: Part of work covered by submittal may proceed provided it complies with requirements of Contract Documents. Final acceptance will depend upon that compliance. The term "approved" shall only indicate that there is no exception taken to the submittal.

3. No Exception As Corrected: Part of work covered by submittal may proceed provided it complies with notations and corrections on submittal and requirements of Contract documents. Final acceptance will depend upon that compliance.
4. Revise And Resubmit: Do not proceed with part of work covered by submittal including purchasing, fabricating, and delivering. Revise or prepare new submittal in accordance with notations and resubmit.

E. Samples:

1. Submit samples to illustrate functional and aesthetic characteristics of products with all integral parts and attachment devices. Include full range of manufacturer's standard finishes, indicating colors, textures, and patterns for A/E selection. Submit the number of samples specified in individual specification sections. One sample will be retained by A/E.

F. Items Requiring Submittal are as Follows:

1. Test and Balance
2. Insulation
3. Victaulic Mechanical Pipe
4. All items listed in MANUFACTURERS: Section of 23 00 10

1.4 ASBESTOS:

- A. At any time the Contractor encounters asbestos, he shall immediately stop work in the immediate area and suspend any further work until asbestos is removed. Contractor shall, upon discovery of asbestos, notify owner, or owner's representative, who shall be responsible for the removal of the asbestos, all in accordance with NESHAP (National Emission Standard for Hazardous Air Pollutants). Any form of asbestos removal or demolition shall be by owner. Engineer is not an "Owner or Operator" as defined under NESHAP.
- B. Contractor is responsible for, and shall be aware of all state and federal laws pertaining to asbestos as well as NESHAP requirements.

1.5 LEAD FREE:

- A. All solder, flux and pipe used in water system must be lead free. Lead free is defined as less than 0.2 percent lead in solder and flux and less than 8.0 percent lead in pipes and fittings.

1.6 AMERICANS WITH DISABILITIES ACT:

- A. All items or work under this division of the specifications shall comply with guidelines as set forth in the Americans With Disabilities Act.

1.7 PERMITS AND FEES:

- A. Pursuant to S.C. Code Ann. § 10-1-180, no local general or specialty building permits are required for state buildings. The Contractor shall secure and pay for all other permits, fees, and licenses by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

1.8 DEFINITIONS:

- A. In this division of the specifications and accompanying drawings, the following definitions apply:
- B. Provide: To purchase, pay for, transport to the job site, unpack, install, and connect complete and ready for operation; to include all permits, inspections, equipment, material, labor, hardware, and operations required for completion and operation.
- C. Install (Installed): To furnish and install complete and ready for operation.
- D. Furnish: To purchase, pay for, and deliver to the job site for installation by others.
- E. The Mechanical Contractor is cautioned that "furnish" requires coordination with others. Such coordination costs shall be included as part of Mechanical Contractor's bid.

1.9 CUTTING AND PATCHING:

- A. Cutting of walls, floors, roofs, partitions, and ceiling, required for proper installation of the systems shall be performed under this contract.
- B. Cutting shall be done in a neat, workmanlike manner. No joist, beams, girders, columns, or other structural members may be cut without written permission from the Engineer. When possible, holes shall be saw-cut or core drilled neat to minimize patching.
- C. Re-routing of existing pipes, insulation, etc. as required for installation of new system is included in this work. All work shall be done in accordance with specifications for new work of the particular type involved.
- D. Patching shall be performed to match existing structures, exterior walls and roofs, and shall form watertight installation. Where existing ductwork, pipe or other items are removed, the walls, floors, roofs, partitions or ceilings shall be patched to match existing finishes by this contractor.

1.10 VERIFICATION OF DIMENSIONS, ETC.:

- A. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work, working conditions, verify all dimensions in the field, advise the Engineer of any discrepancy, and submit shop drawings of any changes he proposes to make in quadruplicate for approval before starting the work. Contractor shall install all equipment in a manner to avoid building interference.



1.11 COORDINATION WITH OTHER TRADES:

- A. Coordinate all work of each section with work of other sections to avoid interference. Bidders are cautioned to check their equipment against space available as indicated on drawings, and shall make sure that proposed equipment can be accommodated. Before beginning work under each section, inspect installed work of other trades and verify that such work is complete to the point where the installation may properly begin.
- B. Where equipment supplied by an approved manufacturer is substituted for the specified equipment, the Contractor will be responsible for coordinating any changes required in his work or other trades work, including but not limited to electrical requirements, structural steel requirements and space requirements. Any additional costs required to make changes to other trades work shall be borne by this contractor.

1.12 PROTECTION OF ADJACENT WORK:

- A. Protect work and adjacent work at all times with suitable covering. All damage to work in place caused by Contractor shall be repaired and restored to original good and acceptable condition using same quality and kinds of materials as required to match and finish with adjacent work.

1.13 EXISTING EQUIPMENT AND MATERIALS:

- A. All items of equipment removed under this section of the specifications shall become the property of this Contractor shall be promptly removed from this site.

1.14 FIRESTOPPING:

- A. Provide firestopping for all mechanical penetrations through fire resistant walls and shaft enclosures, and floor, ceiling, and roof elements of fire resistant assemblies. Firestopping shall provide rating comparable to rating of structure it protects.
- B. Firestopping materials currently classified with UL as "Through Penetration Firestop Systems".
- C. Firestopping materials shall have been tested in accordance with UL 1479 "Fire Tests of Through Penetration Firestops".

1.15 CLEAN-UP:

- A. At the completion of the contract work, all areas where work has been performed shall be left clean. All trash shall be removed from the site by the Contractor.

1.16 APPROVALS AND SUBSTITUTIONS:

- A. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such references shall be interpreted as establishing a standard of quality and shall not be

construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, or type of construction which, in the judgment of the Engineer, expressed in writing, is equal to that specified.

- B. Requests for written approval to substitute materials or equipment considered by the Contractor as equal to those specified, shall be submitted for approval to the Engineer ten (10) days prior to bid date. Requests shall be accompanied by samples, descriptive literature and engineering information as necessary to fully identify and evaluate the product. No increase in the contract sum will be considered when requests are not approved.
- C. The Contractor shall bear the burden and cost of coordinating with all trades any changes in work required by substitutions, including but not limited to electrical connections, additional components required, service clearance, etc.

#### 1.17 AS-BUILT DRAWINGS:

- A. The Contractor shall keep a record set of drawings on the job; and as construction progresses shall show the actual installed location of all items, material, and equipment on these job drawings. Indicate approved changes in red ink.
- B. At the time of final completion, a corrected set of As-Built drawings shall be delivered to the Engineer. A final set of reproducible drawings with job information that reflects the actual installation shall be prepared by the Engineer and given to the Owner.

#### 1.18 WARRANTY:

- A. The Contractor for each section of the work under this division will furnish to the Owner a written warranty for the installation as installed, including controls and all other equipment covered under each section of the specifications, to perform in a quiet, efficient, and satisfactory manner with no more than normal service.
- B. Each warranty shall extend for a period of one year following substantial completion and acceptance of construction. They shall be endorsed by the Contractor. Refrigeration compressors shall have a five (5) year warranty.

#### 1.19 MANUFACTURERS:

- A. In order to define requirements for quality and function of manufactured products, and requirements such as size, gauges, grade selection, color selections and like specifications requirements, the specifications as written hereinafter are based upon products of those manufacturers who are named hereinafter under various specifications for materials.
- B. In addition to products of manufacturers named hereinafter in the specifications, equivalent products of the following named manufacturers will be acceptable under the base bid:

1. Air Handling Units:
  - a) The Trane Company, Daikin Applied, Johnson Controls, Carrier Air Conditioning Company
2. Fan Coil Units:
  - a) The Trane Company, ETI, Rittling, Johnson Controls
3. Packaged 100% Outside Air Units:
  - a) The Trane Company, Daikin Applied, Johnson Controls, Carrier Air Conditioning Company
4. Ductless and Ducted Split Heat Pumps:
  - a) Mitsubishi, Daikin, Trane, Johnson Controls
5. Air Filters:
  - a) Farr Filter Company, Flanders Filters, American Air Filter Company
6. Variable Air Volume Boxes:
  - a) The Trane Company, Environmental Technologies, Price Company, Titus Manufacturing Company, Nailor Industries, Krueger, Johnson Controls, Carrier Air Conditioning Company, MetalAire
7. Electric Unit Heaters:
  - a) Carrier Air Conditioning Company, The Trane Company, McQuay International, Markel Products Company, Electromode, Berko, Inc., Q-Mark, Raywall, Redd-I, Indeeco
8. Air Distribution:
  - a) Metal Industries, Price Company, Titus Manufacturing Company, Nailor Industries, Anemostat Products Division, Krueger, J & J Register Co., Carnes Company, Tuttle and Bailey, AirGuide Manufacturing
9. Fans:
  - a) Greenheck Fan Corporation, Loren Cook Company, Breidert/Jenn Fans, Carnes Company, ACME, PennBarry, American Coolair/ILG

10. Dampers:
  - a) Ruskin Manufacturing Company, Greenheck, NCA Manufacturing, Safe Air/Dowco, Inc., CESCO Products, Inc., Leader Industries, Pottorff, Arrow United, Young Regulator, Nailor Industries
11. Fire and Smoke Dampers:
  - a) Ruskin Manufacturing Company, Greenheck, NCA Manufacturing, Safe Air/Dowco, Inc., CESCO Products, Inc., Leader Industries, Pottorff, Prefco Products, Nailor Industries
12. Louvers:
  - a) Ruskin Manufacturing Company, Greenheck, NCA Manufacturing, Safe Air/Dowco, Inc., CESCO Products, Inc., Leader Industries, Pottorff, Arrow United, Nailor
13. Kitchen Hoods:
  - a) Denlar, Greenheck, Captive Aire, Grease Master, Penn Ventilation, Aerolator Systems Inc.
14. Spiral and Oval Duct and Fittings:
  - a) Eastern Sheet Metal, Linx Industries, Semco, Inc., United Sheet Metal, Spiral Pipe of Texas, Hamlin Sheet Metal, EHG Duct, Dixie Sheet Metal, Silversheet Enterprises, Turnkey Duct Systems, McGill Airflow
15. Seismic and Vibration Equipment:
  - a) Mason Industries, Vibration Mountings & Controls, Inc., Amber/Booth Company, Vibration Eliminator Co., Kinetics Noise Control
16. Pumps:
  - a) Bell and Gossett Company, Taco, Inc., Patterson Pumps
17. Variable Frequency Drives:
  - a) ABB, Danfoss, Yaskawa, Trane
18. Automatic Flow Control Valves:
  - a) Flow Design Inc, Griswold Controls, Nexus Valve, PRO Hydraulics
19. Hot Water Convertors:
  - a) Bell and Gossett Company, Taco, Inc. Patterson-Kelley

20. Condensate Units:
  - a) Domestic Pump Company, Shipco, Sarco Company, Fabtek
21. Steam Specialties:
  - a) Sarco Company, ITT, Hoffman & Armstrong
22. Temperature and Air Pressure Gages:
  - a) Dwyer Instruments, Weiss Instruments, H.O. Trerice Company, Ellison Draft Gauge Company, Inc., Weksler Instrument
23. Insulation:
  - a) Owens Corning, Johns Manville, CertainTeed Corporation, Knauf Insulation
24. Temperature Controls:
  - a) Johnson Controls
25. Safety Valves:
  - a) Watts Regulator Company, McDonnell and Miller, Inc., H.A. Thrush & Company.
26. Control Valves:
  - a) Spence Engineering Company, Inc., Leslie Company, Fisher Governor Company, Watson McDaniel.
27. Water Valves:
  - a) Nibco, Kitz, Apollo, Adams, Zwick, Velan, Demco
28. Steam Valves:
  - a) Under 40 psi: Milwaukee 148 Series
  - b) Over 40 psi: Sharp Series 3483
29. Pipe Hangers:
  - a) Cooper B-Line, Fee and Mason Manufacturing Company, Anvil International, Erico Caddy, Tolco a Division of Nibco

30. Identification Items:

- a) Seton Name Plate Company, W.H. Brady Company, Handley Industries, Inc.

PART 2 - PRODUCTS

2.1 PAINTING:

- A. Furnish touch up paint supplied by equipment manufacturer.
- B. Coat ferrous metal surfaces that do not have factory painting or galvanizing with one coat of Sherwin Williams high heat aluminum paint.

2.2 CONCRETE EQUIPMENT FOUNDATIONS:

- A. Use 3000-psi "batch plant" concrete or approved "precast" reinforced concrete foundations.

2.3 NAME PLATES:

- A. All equipment provided under this division shall be labeled with a Bakelite nameplate 1" x 3" minimum with 3/8" minimum height lettering as manufactured by Seton Name Plate Company. See filter nameplate requirement below.
- B. Provide labels on ceiling grid at Air Handlers and VAV boxes with 1/8" high lettering to identify access location.

2.4 VALVES:

- A. All valves provided under each section shall be of a single manufacturer unless otherwise specified. Leave packing for all valves in good condition, replacing as necessary for completion of work. Packing is to be of an approved material suitable for required service. Valve manufacturer and pressure rating shall be cast on side of valve body. Each threaded valve shall have a union installed adjacent to it. All valves shall be of listed manufacturer as scheduled hereinafter in other sections of Division 23. Valves on insulated pipes shall have handle extensions the thickness of the insulation.

2.5 FAN INLET SCREENS:

- A. Provide protective inlet screens for all centrifugal supply and exhaust fans where not duct connected on inlet. Screens shall consist of 22 gauge, 2" x 1", diamond shaped galvanized metal secured by bolted galvanized band iron.

2.6 EQUIPMENT ACCESSORIES:

- A. Where flexible couplings are required, they shall be similar to Faulk Corporation, Type F Steelflex. All couplings shall be provided with guards.

- B. Lubrication: Provide oil level gauges, grease cups, and grease gun fittings for all equipment bearings as recommended by equipment manufacturer. All grease gun fittings shall be of a uniform type.

## 2.7 FILTERS:

- A. Provide one new set of MERV 13 pleated filters in each unit at final completion. Provide the Owner one replacement set of filters with a complete filter list indicating unit tag and size and quantity of filters needed. At each filter door provide a Bakelite nameplate 1" x 3" minimum with 1/8" minimum height lettering as manufactured by Seton Name Plate Company, that indicates the size and quantity of each filter required in that particular unit.

## 2.8 VALVE TAGS AND SCHEDULE:

- A. Provide separate typewritten list of all valves, giving number and use and control of each, on a small scale drawing outlining the general run of pipe lines and showing the location of valves for each section of work. Pipe lines in diagram shall be color coded to match piping. Drawings to be framed under glass and located in the equipment room. Provide a 1-1/2" diameter round brass numbered tag secured to each valve with "S" hook, Style P-250 BL as manufactured by Seton Name Plate Company, Brady Worldwide, Brimar Industries, or equal.

## 2.9 THERMOMETERS FOR PIPING:

- A. Thermometers, except where otherwise specifically noted on drawing, shall be equal to Weiss Instruments model DVU35.
- B. All thermometers shall be digital solar powered with a stem assembly suitable for mounting in a threaded pipe well. The thermometer shall have an adjustable angled body.
- C. Thermometer Wells:
  - 1. Thermometer wells shall be provided at all points indicated on the drawing. Thermometer wells shall be designed to hold an engraved stem thermometer. The wells shall be made of heavy brass and shall be approximately six inches long, shall project two inches into the pipe and shall have dust protecting caps and chains. Pipes smaller than 2-1/2 inches in size shall be enlarged at the points where the wells are installed. Wells shall be set vertical or at an angle so as to retain oil.

## 2.10 PRESSURE GAUGES:

- A. Pressure gauges shall be installed as indicated on the drawing. Pressure gauges shall be equal to Weiss Instruments model 4CTS. Pressure gauges shall be single spring bourdon tube type with wear resisting moving parts and adjustable linkage. Gauge movement shall be suitable mounted in a cast aluminum case with glass front and plain removable ring.
- B. Each gauge shall be equipped with a brass needle valve.
- C. Each steam gauge shall be equipped with syphon.

- D. Gauges shall be installed in such a manner so as to be accessible and easily read. Range of gauge for each particular point of application shall be selected so that pointer is approximately in midpoint of scale under normal operating conditions.

#### 2.11 FIRESTOPPING MATERIALS:

- A. The material used to fill the annular space shall prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E 119 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inches of water at the location of the test specimen for the time period equivalent to the fire resistance rating of the construction penetrated. Material shall be capable of curing in the presence of atmospheric moisture to produce durable and flexible seal, and will form airtight and watertight bonds with most common building materials in any combination including cement, masonry, steel, and aluminum.

#### 2.12 SLEEVES AND OPENINGS:

- A. Provide UL certified fire stop sleeving system for all pipe penetrations through fire rated walls, floors, partitions, ceilings, floor-ceiling assemblies and roofs as tested under ASTM E814-13A "Standard Method of Fire Tests of Through Penetration Fire Stops".

#### 2.13 SEISMIC RESTRAINTS:

- A. Seismic restraints shall be provided per International Building Code Chapter 16 for Category C Buildings (See Code Compliance on Drawing Cover Sheet), specification section 23 05 48 and the drawings.

### PART 3 - EXECUTION

#### 3.1 CONCRETE EQUIPMENT FOUNDATIONS:

- A. Consult ASHRAE: A Practical Guide to Seismic Restraint, Chapter 6 for specific reinforcement and anchoring details, with respect to pad size and seismic forces. Unless otherwise noted, set all floor mounted and "on-grade" mounted equipment on 6" high concrete foundation pads. Concrete foundations shall be reinforced with #4 bars - 12" o.c. both ways, or as directed by A Practical Guide to Seismic Restraint. Pads shall be approximately 6" larger than equipment base, and have 1" x 1" chamfer on all edges. Pads shall have carborundum brick rubbed finish. Surface finish shall be uniformly smooth. Concrete floor shall be rough and foundation doweled to floor per A Practical Guide to Seismic Restraint.

#### 3.2 PIPE FITTINGS:

- A. General: Provide complete systems of piping and fittings for all services as indicated. All pipe, valves, and fittings shall comply with American National Standards Institute, Inc. Code and/or local codes and ordinances. All fittings shall be domestically produced from domestic forgings. Cut pipe accurately to measurements established at building or site, and



work into place without springing or forcing, properly clearing all windows, doors, and other openings or obstructions.

- B. Excessive cutting or other weakening of building to facilitate piping installation will not be permitted. Piping shall line up flanges and fittings freely and shall have adequate unions and flanges so that all equipment can be disassembled for repairs. Test all piping prior to insulation or concealing.
- C. All welded pipe and fittings shall be delivered to job with machine beveled ends. Where necessary, beveling may be done in field by gas torch. In which case, surfaces shall be thoroughly cleaned of scale and oxidation after beveling.
- D. Screwed piping shall have tapered threads cut clean and true; and shall be reamed out clean before erection. Each length of pipe, as erected, shall be upended and rapped to free it of any foreign matter.

### 3.3 WELDING:

- A. All welding shall be done by certified welders. Welded pipe shall have flanges at valves and elsewhere as required to permit disassembly for maintenance. Tests and reports shall be as follows:
- B. Qualification test of each welder prior to beginning of construction.
- C. One sample of weld of each welder's work selected at random by Engineer during construction period.
- D. Procedure for making tests of welds shall be as outlined in Section 9 of ASME Boiler Construction Code. These tests shall be made by an approved testing laboratory, and a report furnished to Engineer. Report on qualification tests shall be made for gas welding and electric arc welding on steel in horizontal fixed position. A testing laboratory representative shall witness making of welds made for qualification tests. All costs of testing of welds shall be paid by Contractor.

### 3.4 PIPE:

- A. All piping material shall be as specified in other sections of this division.
- B. Fittings and Connections: All turns and connections shall be made with long radius fittings as scheduled hereinafter. No miter connections will be permitted in welded work.
- C. Pipe joints shall be made in accordance with the following applicable specifications:
  - 1. Make up flanged joints with ring-type gaskets, 1/16 inch thick.
  - 2. Weld-O-Lets, or similar approved fittings, may be used if branch pipe is less than one-half the size of the main. In all other cases, welding fittings shall be used. All welded piping shall be as specified hereinbefore.

3. Make all solder joints with non-corrosive type flux 95 Percent tin and 5 percent antimony alloy solder.
- D. Threaded Pipe: Threaded joints shall have American Nation taper screw threads with graphite and oil compound applied to male thread.
- E. Plastic Pipe: Joints for polyethylene and polypropylene pipe and fittings shall be made by heat fusion. Approved mechanical compression type joints may be provided in lieu of joints made by heat fusion for polypropylene pipe. Installation and testing of mechanical compression joints shall be in accordance with the manufacturer's recommendations. Joints for acrylonitrile-butadiene-styrene and polyvinyl chloride pipe and fittings shall be made using solvent cement. Threaded joints shall be used only where required for disconnection and inspection.

### 3.5 SLEEVES:

- A. Provide all sleeves in floors, beams, wall, roof, etc. as required for installing work of this division unless otherwise specified hereinafter. Size sleeves for insulated pipe to accommodate both pipe and insulation. Construct vertical sleeves in connection with concealed piping of 22 gauge galvanized iron. Sleeves thru fire-rated assemblies shall be firestopped as specified herein and insulation shall not pass thru sleeve unless material complies with firestopping specified.

### 3.6 PIPE HANGERS, SUPPORTS AND INSERTS:

- A. Pipe hangers, supports and inserts shall comply with Table 305.4 of the International Mechanical Code and be provided as follows:
- B. All piping shall be supported by forged steel hangers or brackets suitably fastened to structural portion. Wall brackets shall be Fee & Mason Fig. No. 151. Provide lock nuts on all adjustable hanger assemblies.

PIPE SIZE - INCHES

	1/2 – 2	2-1/2 – 4	6 – Up	Wall Plate Hanger
Grinnel	104	260	171	139
Fee & Mason	199	239	170	302
Elcen	92	12	15	---

- C. Hanger or Support Spacing (unless specified different hereinafter):

#### 1. Copper Pipe:

Nominal Pipe Size – Inches	Maximum Span - Feet
1-1/4" and under	6' and at each change in direction
1-1/2" and above	10' and at each change in direction

2. Steel Pipe:

12'- 0" intervals and at each change in direction

- D. Size hangers on insulated piping to permit insulation and saddles to pass full size through hanger.

E. Trapeze Hangers:

1. May be used for groups of pipes close together and parallel. Trapeze hangers may be constructed from structural channel or angle irons or from pre-formed channel shapes. All pipe lines must be held on specific centers by U bolts, clips or clamps.
2. When supported with uni-strut an insulation sleeve under the clamp equal to Armacell Armafix is required.

F. Special and Additional Supports:

1. Special supports will be required where hangers cannot be used. Horizontal pipes shall be secured to prevent vibration or excessive sway. Where required, provide additional hangers to secure required level, slope or drainage, and also to prevent sagging. Provide a hanger within one foot of each elbow. Provide all miscellaneous steel required for pipe supports, anchors, etc.
2. Pipe supports located on the exterior of the building on grade or on the roof shall be steel with a hot dip galvanized coating.

3.7 INSULATION SHIELDS:

- A. Provide all insulated piping with 10-inch long (16 gauge) protective galvanized sheet metal shields extending 120 degrees around bottom of insulated pipe.

3.8 SWING CONNECTIONS:

- A. Swing connections shall be provided at all points of expansion. Install all connections to equipment, etc. in a manner to allow for normal pipe movement due to thermal expansion without causing undue stresses to be exerted on said equipment.

3.9 REDUCING FITTINGS:

- A. Where pipe lines reduce in size, provide reducing fittings wherever possible. Provide eccentric fittings or reducers where horizontal runs of supply lines reduce in size, and install so that there will be no air trapped in hot or cold water systems. In screwed work, no bushings shall be used unless there is a difference of two standard pipe sizes between inner and outer threads.

3.10 DIELECTRIC CONNECTIONS:

- A. Wherever any connection is made between dissimilar metals, provide dielectric pipe couplings, unions, or nipples rated for 210 degrees F.

3.11 UNDERGROUND BARE STEEL PIPE AND FITTINGS COVERING:

- A. All underground bare steel pipe and fittings shall be wrapped mechanically with asphalt primer, and asphalt-saturated felt or asphalt-saturated glass wrapper bonded to the enamel all in accordance with Asphalt Institute Specification M1. Joints that cannot be factory coated shall be field coated by hand as above.

3.12 ELECTRIC WORK:

- A. All motors, and motor starters shall be furnished for items installed under this division of the specifications. All starters shall be magnetic type. All electrically operated equipment shall have readily accessible nameplates summarizing electrical information (i.e., voltage, phase, horsepower, watts, or amperes). Starters shall be as manufactured by General Electric Company, Westinghouse Electric Company, Cutler-Hammer Inc., or Square D Company. A.C. magnetic starters shall be across-the-line type. Starters shall provide overload protection in each phase and shall otherwise conform to all applicable requirements of these specifications. All magnetic starters shall be combination type, Motor Circuit Protector (MCP) type having interrupting rating equal to or greater than the available short circuit current, with "HAND-OFF-AUTO" selector switch, auxiliary contact, and pilot light in cover. Provide laminated plastic nameplates with white center core for each starter.
- B. For motors controlled by variable frequency drives, provide shaft grounding on the motor equal to Aegis bearing protection ring.
- C. All control conduit and wires and control devices shall be furnished and installed under this division. All contactors shall be of the mechanically held type. All control wiring within starters shall be installed in a workmanlike manner and neatly laced. All control wiring shall be color coded.
- D. All work shall conform with the applicable requirements of the National Electrical Codes. All electrical power characteristics shall be as indicated. All devices, which make and/or break electrical circuits, shall be rated for at least 125 percent of the load.
- E. Relays, contactors, and control devices shall open all ungrounded conductors. All fuses shall be current limiting time delay type equal to Bussman "LPN", 250 volt or "LPS", 600 volt.
- F. Control voltage shall not exceed 120 volts. Control power shall be taken from line terminals of controllers. Where necessary, control transformers shall be provided and shall conform to NEMA Standards, properly sized, and shall be properly fused. Where control voltage is 120 volts, control conductors shall be color-coded.

- G. Electrical power service and connections to all equipment in this division will be made under electrical division of the work.
- H. Manual motor starters with overload protection shall be flush mounted type with pilot light. Square D Catalog No. 2510-FS-1P or General Electric, or Westinghouse equivalent.
- I. Duct smoke detectors shall be provided under electrical division and installed under this division. This division shall provide interlock wiring required for fan shutdown and smoke damper control. Power wiring and fire alarm communication wiring shall be provided under the electrical division.

### 3.13 ITEMS OF MECHANICAL EQUIPMENT:

- A. All items of mechanical equipment electrically operated shall be in complete accordance with paragraph in this division entitled "Electrical Work". Mechanical equipment, other than individually mounted motors, shall be factory pre-wired to a single-set of line terminals and to a single load terminal strip to match load terminals on equipment. Each step shall have properly sized contactor and overcurrent protection.
- B. Mechanical equipment electrical components shall all be bonded together and connected to electrical system ground.

### 3.14 CLEANING:

- A. All surfaces on metal, pipe, insulation covered surfaces, and other equipment furnished and installed under this division of the specifications shall be thoroughly cleaned of grease, scale, dirt and other foreign material.
- B. 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 system with all control devices wide open.

### 3.15 SYSTEM BALANCING:

- A. The HVAC Contractor is responsible for the entire Test & Balance process. The contractor shall employ an independent balancing firm specializing in total system air balancing as approved by the engineer and certified by the AABC or NEBB. The balancing firm shall be employed prior to installation of any ductwork. Provide all labor, engineering and test equipment required to test, adjust, and balance all heating, ventilating, air conditioning, hydronic and exhaust systems.
- B. The Contractor is responsible to have a functioning system prior to Testing and Balancing, to provide a joint and cooperative effort to coordinate the test and balance, and to solve any problems in balancing and controls in order to establish proper system performance before leaving the job. The Contractor is responsible for providing the Test and Balance Agency (TAB) with a complete set of project drawings, specifications, and submittals, and for providing and installing new sheave or sheaves, new belts, as required, if a change in fan speed is necessary which cannot be made by adjusting the sheave originally installed. When requested by the Engineer, the TAB Agency will review plans and specifications of

the systems prior to installation and submit a report of any deficiencies, which could preclude proper adjusting, balancing and testing of the system. The TAB agency shall submit copies of deficiency reports along with a preliminary report to the Engineer for review prior to final submittal.

- C. Instruments used will be those that meet the instrument requirements for Agency Qualifications of the AABC as published in the NEBB "Procedural Standards for Testing Adjusting and Balancing of Environmental Systems" or the AABC "National Standards for Total System Balance".
- D. Fan air volume shall be adjusted to within 5% of design, and diffuser air volumes to within 10% of design.
- E. Water volumes shall be adjusted to within 10% of design whenever balancing cocks or flow meters are installed. Where automatic flow control valves are shown, pressure drop readings shall be taken across the coils to verify flow. After system balancing, the Mechanical Contractor shall trim pump impellor or adjust pump speed to maintain flow at design conditions. The pump flow shall not be restricted by valves to reduce flow volume.
- F. Ductwork rated 4" w.g. and higher, all laboratory exhaust ducts, and ductwork indicated on the drawings shall be tested for leaks. All branch runouts and takeoffs shall be installed and capped before duct leakage testing is performed. Testing is not required for ductwork rated 0 to 3" w.g. Testing shall be done following the guidelines in SMACNA-HVAC Duct Leakage Test Manual. Duct test pressure shall be 1½ times scheduled external static pressure. Allowable leakage shall be 2% of total scheduled airflow.
- G. Reporting (Submit five copies of final Test Report)
  - 1. Complete nameplate data and equipment schedule number for all rotating equipment.
  - 2. Design and actual operating data for all rotating equipment including inlet and outlet data, flow rates, amps, voltage and rpm.
  - 3. Design and actual duct and diffuser volumes. Prepare a diagram showing flow measurement points.
  - 4. Design and actual water flow rates. Prepare a diagram showing flow measurement points.
  - 5. Record coil air pressure drop, filter pressure drop, external static pressure, and fan static pressure.
  - 6. Record flow rates, temperatures and pressures across each water coil, condenser and other heat exchangers.
  - 7. Heating equipment nameplate data, equipment schedule number design data, and operating data at maximum achievable load conditions.
  - 8. Duct leakage test results.

### 3.16 TESTING (PIPING):

- A. Upon completion of each system of work under this division, and at a designated time, all piping shall be pressure tested for leaks in the presence of the owner. Owner shall be notified five days before testing is to be conducted and all tests shall be conducted in the

presence of the owner. All equipment required for test shall be furnished by contractor at his expense. All tests shall be performed as specified hereinafter. If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests repeated at no additional cost to owner. Make tight any leaks. Repeat tests until system is proven tight. Caulking of leaks will not be permitted. All equipment not capable of withstanding the test pressure shall be valved off during the test.

- B. Chilled Water and Hot Water Systems: Subject system to 1-1/2 times the working pressure, but not less than 100 psig hydrostatic test pressure. All water piping shall be balanced to produce water quantities as indicated with all automatic control valves wide open.
- C. Steam and Condensate Systems: Upon completion of the installation, but before covering, all steam and condensate piping, and all heating equipment shall be given a hydrostatic test of 1-1/2 times the working pressure, but not less than 100 psig, and proven tight. Equipment not designed for this pressure shall be blanked off.
- D. All refrigerant piping and apparatus shall be tested with dry carbon dioxide or nitrogen plus a small amount of refrigerant. All refrigerating equipment shall be tested under vacuum and shall show no evidence of leakage with an absolute pressure of 0.02 inch mercury gauge, sustained for a period of one hour without pumping. Leaks shall be corrected by remaking the joint. Test pressures shall be as follows:

High Side

Low Side

Refrigerant 410A - 400 psi

Refrigerant 410A - 350 psi

### 3.17 IDENTIFICATION OF PIPING:

- A. All piping, bare and insulated, installed under this division shall be given two coats of finish painting by this contractor as listed hereinafter. Paint shall be Glidden Industrial Enamel, or equal by Sherwin-Williams or Devoe Paints. Samples of colors and type paint shall be submitted for approval prior to application.
- B. Piping in mechanical rooms shall be painted as follows:
  - 1. Chill Water Supply/Return 7124M "Aqua Fresco"
  - 2. Steam 7266N "Garden Marigold"
  - 3. Condensate 7296N "Barcelona"
  - 4. Heating Hot Water Supply/Return 7205A "Limeburst"
  - 5. Heating Hot Water Heat Exchanger 7205A "Limeburst"

### 3.18 PIPE CODING:

- A. After all piping has been painted with color-coding, all piping installed under this division shall be coded and marked with "Perma-Code" pipe markers as manufactured by W.H. Brady Company, 712 Glendale Avenue, Milwaukee, Wisconsin. Markers shall be applied to properly identify piping, but in no case shall they be applied more than 20 feet apart. Markers shall be 1-1/8 inch by 7 inches and shall be secured by spiral wrapping with 3/4 inch wide vinyl banding tape, color matching service, at each end of marker.

### 3.19 IDENTIFICATION OF EQUIPMENT IN MECHANICAL AREAS:

- A. All items of mechanical equipment shall be identified with a black bakelite label with engraved white lettering 1/2" tall. Labels shall be mechanically attached to the equipment with rivets or stainless steel screws. Thermostats and control devices shall be identified with a black bakelite label with engraved white lettering 1/4" tall. Lettering shall correspond with the tags shown in the drawings.

### 3.20 ADJUSTMENT AND TRIAL RUNS:

- A. Upon completion of all work, the contractor shall operate the system in the presence of the owner for the purpose of demonstrating quiet and satisfactory operation, the proper setting of controls, safety and relief valves, and cleanliness of system. Heating and cooling shall be tested separately during periods approaching design conditions and shall fully demonstrate fulfillment of capacity requirements. Test procedures shall be in accordance with applicable portions of ASME, ASHRAE, and other generally recognized test codes as far as field conditions will permit. Any changes or adjustment required shall be made by the contractor without additional expense to owner.
- B. Document and submit all operating conditions (startup report) of equipment during trial runs and after test and balance is complete. Include in the report:
  - 1. Ambient air temperature
  - 2. Design operating temperatures and flow rates
  - 3. Entering and leaving air temperatures across each coil or heating device
  - 4. Entering and leaving water temperatures at each coil
  - 5. Entering and leaving water temperatures at each chiller, boiler or heat exchanger
  - 6. Amp draw of all motors and nameplate amps
  - 7. Voltage at each piece of equipment
  - 8. Refrigerant pressures and temperatures
- C. All equipment shall be started and tested for proper operation per the manufacturer's recommended startup procedure. The following items shall be verified and documented in the startup reports.
  - 1. Verify equipment is in accordance with equipment submittal (confirm all components are installed and provided as indicated)
  - 2. Verify unit nameplate voltage with voltage available at jobsite
  - 3. Verify all electrical connections are tight
  - 4. Verify control wiring as required (refer to Controls section of manufacturer's IOM & jobsite specific requirements in accordance with equipment submittal)
  - 5. Verify disconnect and fuses are sized in accordance to unit data plate
  - 6. Verify heater piping or electrical supply in accordance with manufacturer's IOM
  - 7. Verify drain piping is installed in accordance with manufacturer's IOM
  - 8. Verify Economizer operation and proper installation
  - 9. Verify sensors shipped with Economizer as described in installation literature are properly installed and functioning correctly



10. Check supply and exhaust fan belts for proper tension, as applicable and in accordance with manufacturer's IOM
  11. Verify proper unit control setup and function (I.e configure features such as single zone VAV and multizone VAV as required by the IOM)
  12. Verify unit sequence of operations function in accordance with manufacturer's IOM (heating sequence & cooling sequence)
  13. Verify unit clearances are in compliance with manufacturer's IOM
- D. Provide a factory startup as indicated in the equipment schedules. Factory startup shall be performed by technicians that are factory trained and certified, and in the employ of the manufacturer's rep.
- 3.21 OPERATION AND MAINTENANCE INSTRUCTIONS, AND MAINTENANCE MANUAL:
- A. Upon completion of work, and at a time designated by the engineer, a competent employee of the contractor shall be provided to instruct a representative of the owner in the operation and maintenance of the system.
- B. Minimum instruction period shall be:
1. Air Conditioning System - 1 day
- C. Maintenance Manuals: The contractor shall compile and bind five (5) sets of all manufacturer's instructions and descriptive literature on all items of equipment furnished under this work. These instructions shall be delivered through the general contractor to the engineer for approval prior to final inspection.
- D. Instructions shall include:
1. Warranty letter signed by the Mechanical Contractor.
  2. Index for each section with each section properly identified.
  3. Complete equipment list with model and serial numbers.
  4. Complete equipment list with filter sizes and quantities.
  5. Copy of one complete, approved submittal for each equipment section.
  6. Description of each system, including manufacturer's literature for all items.
  7. Start-up and shut-down description for each system.
  8. Suggested operating and maintenance instructions with frequency of maintenance indicated.
  9. Parts list for all items of equipment.
  10. Name, address, and telephone number of nearest sales and service organization for all items of equipment.
  11. Startup reports.
  12. Test and Balance Reports
- E. Manuals shall be 8-1/2 x 11 inch text pages bound in three ring expansion binders with a hard durable cover with clear plastic pocket on front for title page. Prepare binder covers with printed subject title of manual, title of project, date, and volume number when multiple binders are required. Printing shall be on face and spine. Provide a table of contents for each volume. Internally subdivide the binder contents with divider sheets with typed tab

titles under reinforced plastic tabs. Provide directory listing as appropriate with names addresses, and telephone numbers of design consultant, Contractor, subcontractors, equipment suppliers, and nearest service representatives.

- F. Manuals shall be 8-1/2 x 11 inch text pages in digital PDF format. Manual shall be submitted as a single PDF file. Prepare file cover with printed subject title of manual, title of project, and date. Provide a table of contents for each volume. Internally subdivide the file contents with bookmarks providing a link to each section. Provide directory listing as appropriate with names addresses, and telephone numbers of design consultant, Contractor, subcontractors, equipment suppliers, and nearest service representatives.

End of Section 23 00 10

## SECTION 23 05 00 – HEATING, VENTILATION and AIR CONDITIONING

### PART 1 - GENERAL

#### 1.1 GENERAL REQUIREMENTS:

- A. This Section of the Specifications and related drawings describe requirements pertaining to Air Conditioning, Heating and Ventilation work, including applicable HVAC Insulation in separate Section 23 07 00, Vibration Isolation and Seismic Restraint in separate Section 23 05 48 and Central Control and Monitoring System in separate Section 23 09 00. All work shall comply with Section 23 00 10 - General Provisions - HVAC.
- B. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2016 Edition. All ductwork must comply with all local, state and federal code requirements.

### PART 2 - PRODUCTS

#### 2.1 SUBMITTALS:

- A. Ductwork shop drawings must be submitted for approval by Engineer. Any ductwork installed without prior approval by the Engineer shall be replaced at the expense of the contractor.

#### 2.2 QUALITY ASSURANCE:

- A. The contractor must comply with this specification in its entirety. At the discretion of the Engineer, sheet metal gauges, and reinforcing may be checked at various times to verify all duct construction is in compliance.

#### 2.3 DUCTS, PLENUM, ETC.:

- A. As indicated on drawings, provide a system of metal ducts for supply, return and exhaust air.
- B. All sheet metal, ducts, casing, plenums, etc., of sizes indicated, shall be constructed from prime galvanized sheet steel.

#### 2.4 DUCTS THRU WALLS:

- A. Provide sheet metal flashing around all duct penetrations.
- B. Ducts shall be properly sealed per the fire rating and UL assembly.

2.5 INSTRUMENT TEST HOLES:

- A. Install for air handling units instrument test holes in supply, return and outside air duct. Instrument test connections shall be Ventlock Model 699-2, or equal, and shall be located in accessible locations.

2.6 AIR DISTRIBUTION:

- A. Devices shall quietly and draftlessly deliver and/or remove air quantities required to attain conditions indicated. Exposed surfaces shall have baked enamel finish of manufacturer's standard colors noted.
- B. All air distribution equipment and accessories shall be as scheduled on drawings.

2.7 METAL DUCTWALL:

- A. All interior ducts shall be constructed of G-90 or better galvanized steel (ASTM A653) LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions shall be constructed of G-90 or better galvanized steel LFQ, chem treat. Galvanized metal ducts shall be a minimum thickness of 24 gauge.
- B. Dryer exhaust shall be aluminum alloy number 3003-H14 (ASTM B-209) and not less than 0.034" in thickness.
- C. Support, access doors not part of ducts, bar or angle reinforcing damper rods and items made of uncoated mild steel shall be painted with two coats of primer or provide galvanized equivalent.
- D. Medium Pressure Supply Duct:
  - 1. Ductwork from the supply air fan to the terminal velocity reduction device (VAV box) shall be fabricated to meet minimum 4" w.g. pressure class in accordance with SMACNA Duct Construction Standard.
- E. Low Pressure Supply, Return, and Exhaust Duct:
  - 1. Ductwork downstream from the VAV box, ductwork on low pressure supply and return systems and restroom exhaust duct shall be fabricated to meet minimum 2" w.g. pressure class in accordance with SMACNA Duct Construction Standard.

2.8 RECTANGULAR DUCT LONGITUDINAL SEAMS:

- A. Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Button punch snap lock is not acceptable.

2.9 ROUND DUCT LONGITUDINAL SEAMS:

- A. Spiral seam or snap lock seam shall be used on all longitudinal seams for low pressure round duct.

## 2.10 DUCT JOINTS:

- A. Duct joints to meet criteria as defined in SMACNA's 2016 Manual, HVAC Duct Construction Standards, Metal and Flexible.
- B. Ductmate or W.D.C.I. proprietary duct connection systems will be accepted as an alternative to SMACNA duct construction standards. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
- C. Ductmate 440 or a Butyl Rubber Gasket which meets Mil-C 18969B, Type II Class B, TT-C-1796A, Type II Class B, and TTS-S-001657 must also pass UL-723. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth associated with dark, damp areas of ductwork. The recommended test procedure for bacterial and fungal growth is found in 21CFR 177, 1210 closures with sealing gaskets for food containers.

## 2.11 ACCESS DOORS IN DUCTWORK:

- A. Provide access doors at all apparatus requiring service and inspection, including fire dampers and fire smoke dampers, and where indicated. Access doors for 2" pressure class duct shall be hinged or Ductmate Sandwich Access Doors as manufactured by Ductmate Industries, Inc., or equal. Access doors for 4" pressure class duct shall be Ductmate Sandwich Access Doors as manufactured by Ductmate Industries, Inc., or equal. Access doors shall be double wall construction with high density fiberglass insulation with R value equal to or greater than the duct insulation. Doors shall be of adequate size (12" x 12" minimum) as required to allow easy access to hardware which needs to be maintained. In accordance with the requirements of the International Building Code, contractor shall permanently mark any access doors or other openings that serve as a means of access to fire, smoke and fire/smoke dampers with ½" letters reading "Fire Damper", "Smoke Damper", or "Fire/Smoke Damper". Label shall be permanently and securely attached.

## 2.12 FLEXIBLE DUCT:

- A. Flexible duct to meet criteria as defined in SMACNA's 2016 Manual, HVAC Duct Construction Standards, Metal and Flexible, or as defined within. Flexible air ducts and flexible air connectors shall be tested in accordance with UL 181, and listed and labeled as Class 0 or Class 1.
- B. Flexible duct shall be constructed with a polyethylene core with foil faced insulation.
- C. Flexible duct is not allowed in lengths greater than 5', unless otherwise noted. Bends, turns, or sagging, is not accepted.
- D. Flexible duct shall only be used for supply and return duct run out connections at diffusers and grilles. Flexible duct shall not be used for exhaust duct.

2.13 MEDIUM PRESSURE ROUND AND FLAT OVAL DUCTS:

- A. Construction: In accordance with HVAC Duct Construction Standards, Section III.
- B. Round and flat oval ductwork shall be Oval Spiral Duct spiral seam construction only. Gages shall be in accordance with SMACNA Duct Construction Standard and fittings in accordance with SMACNA Duct Construction Standard, except as noted.
- C. All fittings other than elbows shall be fabricated by spot-welding each metal joint and sealing with a bonding material having a neoprene base to prevent leakage at these joints. Fittings shall be 26-gauge. Takeoff fittings shall be conical tees.

2.14 MEDIUM PRESSURE ROUND AND FLAT OVAL DUCT JOINTS:

- A. Joints 0"-20" diameter, interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening.
- B. Joints 21"-72" diameter, use 3 piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Example: Ductmate Spiralmate or equal.
- C. Joints 73" diameter and up, use companion angle flanged joints only as defined on pages 3-6 of the SMACNA Manual. Refer to manual for proper sizing and construction details. Ductwall to be welded longitudinal seams.
- D. Flat Oval Ducts shall be joined with the Ovalmate Connection System manufactured by Ductmate Industries. Consult the manufacturer for installation and construction guidelines. As an option, beaded sleeve joints may be used.

2.15 SEALERS:

- A. Duct sealer shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall seal out water, air, and moisture. Sealer shall be UL listed and conform to UL181B and marked 181 B-M. Sealer shall be Childers CP-145A, or equal.

2.16 DUCTWORK HANGER/SUPPORT:

- A. Hang and support ductwork as defined by SMACNA, Chapter 5 2016 Manual, First Edition, or as defined within. Hanger spacing for sheet metal duct not to exceed 8'. Hanger spacing for flexible duct shall not exceed 5'.
- B. Duct supports on the exterior of the building on grade or on the roof shall be steel with a hot dip galvanized coating.

## 2.17 TURNING VANES:

- A. Turning vanes shall be double wall turning vanes fabricated from the same material as the duct. Tab spacing shall be SMACNA Standard. Rail systems with non-standard tab spacings shall not be accepted. All tabs shall be used, do not skip tabs. Mounting rails shall have friction insert tabs which align the vanes automatically. Vanes shall be subjected to tensile loading and be capable of supporting 250 lbs. when fastened per the manufacturers instructions.

## 2.18 FIRE DAMPERS:

- A. Provide at locations shown on plans, or in accordance with details, schedules or specifications Ruskin fire dampers of appropriate style, or approved equal. Provide fire dampers at all locations as required to comply with National Fire Protection Association Regulations, applicable city requirements, and all local codes or ordinances having jurisdiction. Construct fire dampers as follows:
- B. Fire dampers shall be mounted in a U.L. approved integral sleeve or a No. 16 U.S. Gauge welded steel sleeve 12 inches long. Blades shall be hinged on brass trunnions and counter-weighted when necessary to assure closing. Blade thickness and other construction details shall conform to U.L. 555 and bear U.L. label. Dampers shall be held in open position by 165 degrees fusible link and arranged to lock in position on closure.
- C. Fire dampers in medium pressure duct applications shall be provided with a fully welded, high free area and air tight transition.
- D. Breakaway connections at fire damper sleeves with duct connections shall be made using UL approved "S and Drivemate Connections" or UL approved "Ductmate Breakaway Connections".

## 2.19 COMBINATION FIRE SMOKE DAMPERS:

- A. Provide UL555S listed combination fire-smoke damper. Damper to be Ruskin Model FSD-36 Leakage Class II Combination Fire-Smoke Damper or approved equal. Frame shall be 5 inches by minimum 16 gauge galvanized steel hat channel, reinforced at corners. Damper blades shall be single skin 16 gauge with longitudinal grooves to strengthen blade. Flat blades are not acceptable. Bearings shall be self-lubricating stainless steel sleeve type. Provide silicone blade seals and/or metal jamb seals as required for leakage rating. Blade seals shall be mechanically attached. Glue-on seals not acceptable. Linkage shall be concealed in frame. Provide electric fuse link assembly. Provide 120v actuators, factory mounted and cycle tested. Actuators shall be 2-position, fail close, with end switches. Provide factory sleeve in UL approved gauge. Sleeve shall be factory sealed to assure leakage rating. Minimum sleeve length to be 17" and shall be long enough to allow for proper duct connection on both sides of wall/ceiling. Provide factory picture frame mounting angles in UL approved gauge. Breakaway connections are required on all fire and smoke damper installations unless the damper sleeve is at least 14 gauge galvanized steel. Install dampers, mounting angles, and breakaway connections per Manufacturer's UL installation instructions.

## 2.20 MANUAL OPPOSED BLADE DAMPERS:

- A. Square or Rectangular Dampers 1500 FPM or less and 48" Wide or 48" High and smaller:
  - 1. Provide RUSKIN Model MD-15 or approved equal. Damper shall be multi-blade above 12" in height and shall be opposed blade. Damper frame shall be minimum 18 gauge galvanized steel hat channel. Damper blades shall be 18 gauge galvanized steel single skin with longitudinal grooves for strength. Bearings shall be molded synthetic bearings. Control shaft shall be 3/8" square plated steel. Linkage shall be concealed in frame. Provide hand quadrant with 2" stand-off bracket.
- B. Square or Rectangular Dampers above 1500 FPM or over 48" Wide or 48" High:
  - 1. Provide RUSKIN Model MD-35 or approved equal. Damper shall be multi-blade above 12" in height and shall be opposed blade. Damper frame shall be minimum 16 gauge galvanized steel hat channel. Damper blades shall be minimum 16 gauge galvanized steel single skin with longitudinal grooves for strength. Bearings shall be molded synthetic bearings. Control shaft shall be minimum 1/2" hex plated steel. Linkage shall be concealed in frame. Provide hand quadrant with 2" stand-off bracket.
- C. Round Manual Dampers:
  - 1. Provide RUSKIN Model MDRS-25 or approved equal. Damper frame shall be minimum 7" long with 20 gauge galvanized steel construction. Blade shall be minimum 20 gauge galvanized steel. Bearings shall be molded synthetic. Control shaft shall be minimum 3/8" square steel. Above 20" in diameter use Model CDR-25.

## 2.21 PIPE AND FITTINGS:

- A. Schedule of pipe and fittings: Piping and fittings shall conform to requirements as indicated herein.
- B. All pipe shall be domestically produced from domestic forgings.

## 2.22 EXPANSION JOINTS:

- A. Furnish and install as show on the drawings the Flex-Hose Co.'s FLEXPRESS externally pressurized expansion joints or equal. The design shall incorporate a totally enclosed, externally pressurized stainless steel bellows that is protected from external damage by a heavy-walled shroud designed for full line pressure. The bellows is isolated from flow impingement by an internal schedule 40 carbon steel sleeve. Standard design operating pressure is 150 PSIG. (300 PSIG is also available.) As a result of the externally pressurized design, the operating pressure shall be transferred to the outside of the bellows through a gap between the internal guide flange and the housing (shroud). End fittings shall be flat-face plate carbon steel flanges with 150# ANSI drilling and outside diameter. The bellows may be of single-ply, or laminated (multi-ply) construction to provide a low spring rate with minimal deflection stresses that assure long life. Drain port is provided for convenient



location of steam trap, or used to drain liquids when pipeline is shutdown. Packless design eliminates the need for routine maintenance. Cycle life: 10,000 minimum at full travel. The externally pressurized design will eliminate the need for one set of pipe guides on each side of the expansion joint (4 pipe diameters from the expansion joint) thus permitting the first set of pipe guides to be up to 14 diameters from the expansion joint.

## 2.23 FLEXIBLE PIPE CONNECTOR ON RISER:

- A. Provide 24" long flexible connectors on all pipe riser branch connections as shown on pipe riser detail on sheet M3.1.
- B. Furnish and install PUMPSAVER SMP braided stainless steel pump connectors manufactured by the Flex-Hose Co., Inc. or equal. Construction to be of annular corrugated stainless steel close-pitch hose (made in USA) with stainless steel overbraid (made in USA). The corrugated metal hose, braid(s), and a stainless steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full-penetration TIG weld. End fittings shall be flat-face plate steel flanges with 150# ANSI drilling and outside diameter or carbon steel schedule 40 male NPT thread. Fittings must be attached using a 100% circumferential TIG weld. Braided stainless steel pump connector(s) must be suitable for operating temperatures up to 850oF (455oC). The rated working pressure of the braided metal hose must have a minimum 4:1 safety factor. Each braided stainless steel pump connector shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure. Flanged pump connectors shall be prepared for shipment using cut-to-length spacers, securely positioned between the flanges to prevent axial compression damage and maintain the manufactured length. Spacers must be removed prior to system start up.

## 2.24 SCHEDULE OF PIPING

SERVICE	ITEM	PIPING	FITTINGS	FLANGES OR UNIONS
Steam and Condensate	Steam mains 2-1/2" and larger	Black seamless steel ASTM A-106 or electric weld ASTM A-53 Sch. 40	Buttweld black steel Sch. 40	150 lb. forged black steel welding neck or slip-on flat face
	Condensate 2-1/2" & larger	Black seamless steel ASTM A-106 or electric weld ASTM A53 Sch. 80	Buttweld black steel Sch. 80	150 lb. forged black steel slip-on
Hot & Chilled Water	2" and smaller	Type L, Hard drawn copper	Pro-press copper	Pro-press copper

	2-1/2" and larger	Black steel Sch. 40 ASTM A-53	Buttweld black steel Sch. 40	150 lb. forged forged steel slip-on
Unitary Condensate Drain	2" and smaller	Type L, Hard drawn copper	Pro-press copper	Pro-press copper

2.25 VALVES LIST: All valves of similar type shall be of a single manufacture unless otherwise specified, and be of manufacturer's highest grade.

- A. All valves shall have malleable iron handwheels, valves 2-1/2 and larger cast iron handwheels, self locking stem nuts, and Teflon impregnated stem packing. Valves shall be asbestos free.
- B. Valves exposed to the weather or on chilled water service shall have stainless steel hardware at position plate to prevent rusting.

2.26 AUTOMATIC FLOW CONTROL VALVES:

- A. Flow control valves shall be by Griswold Controls Isolator Y, or equal by Nexus and Flow Design Inc, forged brass body with a stainless steel flow control cartridge assembly. The body design allows inspection or removal of cartridge without disturbing piping connections. Body has an integral handle ball valve, and a union end with interchangeable end pieces for the outlet of the valve body, and an integral 20 mesh stainless steel strainer element. The Isolator Y is provided with two pressure/temperature test valves with a hose bib adapter and cap.

2.27 SHUT OFF VALVES:

- A. Ball Valves:
  - 1. Sizes up to and including 2":
    - a) Ball valves shall be NIBCO 585 ball valves, or Watts, Milwaukee, Apollo or equal, bronze body, threaded or Pro-press ends, 600 psi close off and memory stop with "Nib-Seal" insulated handle.
- B. Butterfly Valves:
  - 1. Butterfly valves shall be equal to Demco Inc. - Series NE lug type or Watts, Nibco or equal, with corrosion resistant stainless steel stems, bronze discs, phenolic backup ring, and shall be suitable for temperature ranges - 10° to 275° F for 2-1/2" and larger. EPT seats shall be field replaceable.
  - 2. Handles for valves 2-1/2" thru 6" shall be infinite throttling with memory stop. Valves 8" and larger shall be gear operated with hand crank and memory stop.

2.28 STRAINERS:

- A. Strainers shall be equal to Spirax Sarco Company Y-pattern sediment separators, or equal by ITT or Armstrong, iron body, monel mesh screen. Sizes 2-1/2 inches and larger to be flanged pattern, Type CI-125; sizes 2 inches and smaller to be screwed pattern Type IT. Where basket type strainers are called for on drawings, they shall be Type Flanged - 125 cast iron large capacity. Strainer to have ball valve blow down with hose end connection and chained cap.

2.29 TRAPS:

- A. Provide traps for all locations indicated on drawings. Inverted bucket traps shall be Armstrong Series 800 or equal by ITT or Spirax Sarco and F & T traps shall be Armstrong Series B or equal by ITT or Sarco. Pressure rating of traps shall exceed that of line that it serves.

2.30 VICTAULIC MECHANICAL PIPE COUPLINGS AND FITTINGS (OPTION):

- A. Chilled, condenser and hot water piping: Victaulic couplings and fittings may be used in lieu of unions, welds, flanges or screwed pipe connection. Piping must be the same schedule as specified for welded piping.
- B. Couplings (Rigid) shall be Victaulic Style – 07, 107N or W07 rigid couplings, with housing fabricated in two or more parts of ductile iron castings, in accordance with ASTM A-536. Coupling gasket shall be Victaulic Grade "E" EDPM of central cavity pressure-responsive design. Couplings shall have electroplated steel nuts and oval track head type bolts to secure grooved pipe and fittings per ASTM A449.
- C. Couplings (Flexible): Victaulic Style 77, 177 or W77 may be used in lieu of a flexible connector for vibration attenuation and stress relief. Installation-ready, suitable for direct stab installation without field disassembly.
- D. Grooved Joint Lubricants: Lubricate gaskets with lubricant supplied by the coupling manufacturer in accordance with published installation instructions. The lubricant shall be approved for the gasket elastomer and system media.
- E. All pipe fittings used with Victaulic pipe couplings shall be fabricated of ductile iron castings in accordance with ASTM A-536. Where Victaulic fitting pattern is not available, fittings fabricated from steel pipe with grooved ends may be used, but must be the same thickness as pipe.
- F. Components shall include fittings, couplings, valves, strainers, flanges, and suction diffusers. (Victaulic 107/07/W07, 761/W761, 716/779/W715, 741/W741, 731/W731)
- G. Victaulic Series 380, 381, 382. Factory assembled grooved end vibration pump discharge drop for pipe sizes 3" through 12" (DN80 through DN300). Orange enamel coated assembly, consisting suctioned diffuser, Wye strainer or a tri-service valve assembly consisting of a spring-actuated check [Venturi-Check] valve and butterfly valve with offset stem for 360-degree circumferential seating, and pipe spool with thermometer and pressure

ports. Assembly is installation-ready, with flexible couplings to accommodate vibration attenuation and stress relief.

- H. All grooved joint couplings, fittings, valves, and specialties shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- I. Pipe grooving shall be in accordance with the manufacturer's specifications contained in latest published literature.

#### 2.31 REFRIGERANT PIPING:

- A. General: Execute all refrigerant piping with stamped type "ACR" hard copper and long radius, wrought copper, sweat fittings with tolerance not to exceed 3/1000 of an inch. All joints shall be made with silver solder. Submit equipment manufacturer's suggested piping diagram for approval.
- B. After refrigerant piping has been installed and tested, each system shall be evacuated and charged with proper refrigerant of quantity as recommended by manufacturer.

#### 2.32 CONVERTERS, EXPANSION TANKS, AIR VENTS AND AIR REMOVAL EQUIPMENT:

- A. Converters, expansion tanks, air vents and air removal equipment shall be of the characteristics and capacities indicated on drawings, and ASME stamped. Install manual air vents at all high points where indicated and where required to properly and adequately vent systems. All above equipment shall be manufactured by one manufacturer, and completed systems shall be installed in accordance with manufacturer's instructions. Certificates shall be furnished to Engineer for all ASME stamped equipment and for performance guarantee of air removal system to prevent air accumulation and air noise in system.

#### 2.33 PRESSURE REDUCING STATION:

- A. Provide a single stage (1/3 – 2/3) steam pressure reducing station of the capacities and characteristics indicated. Pressure reducing station shall be installed complete including strainers, pressure reducing valves, pressure relief valves, gate valves, globe valves, steam traps, pressure gages (bourbon tube) and all other required accessories. Pressure reducing valves shall be Spence Engineering Company Type ED, or equal by ITT or Spirax Sarco, steel flanged ASA 150 pound, pilot operated with a minimum accuracy of plus or minus one psi. Installation to be in accordance with manufacturer's recommendations. Pressure relief valves shall be Farris Engineering Corporation type.

#### 2.34 VENTILATING FANS:

- A. See Schedule for characteristics and accessories. Units shall be AMCA or PFMA certified. Use shaded pole, single phase motors under 1/4 HP and split capacitor or polyphase motors 1/4 HP and larger.

- B. Fans shall be complete with all accessories required for installation including integral overload protection or motor starter.

## 2.35 FAN COIL UNITS:

- A. Provide Enviro Tech Fan Coil Units or approved equal (see Section 23 00 10) of the type, arrangement, size, and indicated capacities and characteristics. Units shall be completely factory assembled, tested and shipped as one piece. All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. All unit dimensions for each model and size shall be considered maximums. Units shall be ETL listed in compliance with UL/ANSI Standard 1995, and be certified as complying with the latest edition of ARI Standard 440.
- B. Construction:
  - 1. All unit chassis shall be fabricated of heavy gauge galvanized steel panels able to meet 125 hour salt spray test per ASTM B-117. Casing shall be internally lined with Elastomeric Closed Cell Foam Insulation. Insulation shall conform to UL 181 for erosion and NFPA 90A for fire, smoke and melting, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21. Polyethylene insulation is not acceptable.
  - 2. All concealed units shall have a minimum 1-1/2" duct collar on the discharge. Plenum and exposed units shall have a minimum 3/4" duct collar on the return.
  - 3. All exposed units shall have exterior panels fabricated of galvanealed steel. The fan and filter bottom access panel shall be attached with quarter turn quick open fasteners to allow for easy removal and access for service.
  - 4. Unit mounting shall be by hanger brackets provided at four locations. Hanger brackets shall include rubber grommet isolators with brass eyelets for threaded rod.
- C. Painted Finish:
  - 1. All painted cabinet exterior panels shall be finished with a heat cured anodic acrylic powder paint of the standard factory color.
- D. Sound:
  - 1. Units shall have published sound power level data tested in accordance with ARI Standard 350-2000 (non-ducted equipment) and ARI Standard 260-2001 (ducted equipment).
- E. Fan Assembly:
  - 1. Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. Motors shall be high efficiency, permanently lubricated sleeve bearing, permanent

split-capacitor type with UL and CSA listed automatic reset thermal overload protection and three separate horsepower taps. Single speed motors are not acceptable.

2. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. The entire fan assembly shall be able to come out of the unit by removing two screws and unplugging the motor. Plenum unit fan assemblies shall be easily serviced through an access panel provided.
3. Devices used to energize and de-energize (switch) fan speeds must be totally silent. Magnetic, mercury, and/or quiet relays and/or contactors are not acceptable.

F. Coils:

1. All cooling and heating coils shall optimize rows and fins per inch to meet the specified capacity. Coils shall have seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin. Fins shall have high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.
2. All coils shall be hydrostatically tested at 450 PSIG air pressure under water, and rated for a maximum of 300 PSIG working pressure at 200°F.
3. Cooling Coil casing shall be fabricated from 304 Stainless Steel.
4. All coils shall be provided with a manual air vent fitting to allow for coil venting.
5. Cooling and heating coils shall be in separate coil casings and have a minimum 2" gap between them and 1-1/2" of clearance on the entering and leaving air sides to allow access from bottom of unit for cleaning when the drain pan is removed. Common tube sheets and coil casing are not acceptable. Water coils on concealed models shall be field reversible for right, left or opposite side connections.
6. Heating coils shall be furnished in the reheat position.

G. Drain Pans:

1. Provide a single wall primary drain pan constructed entirely of heavy gauge type 304 stainless steel for superior corrosion resistance. Drain pans shall be of one-piece construction and be positively sloped for condensate removal. Drain pans on concealed models shall be field reversible for right or left hand connections.
2. The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.
3. Provide a secondary drain connection on the primary drain pan for condensate overflow.

4. Provide an auxiliary drip tray under valve package per detail on plans.

H. Filters:

1. All plenum and exposed units shall be furnished with a minimum 1" pleated filter (MERV 13). Filters shall be tight fitting to prevent air bypass. Plenum unit filters shall be easily removable from the bottom of the unit without the need for tools.

I. Bottom Sheetrock Access Panel:

1. Provide optional telescoping bottom panel with integral return to allow for full service of fan coil and associated piping packages for all ceiling concealed fan coils. Panel shall be factory painted.

J. Electrical:

1. Units shall be furnished with single point power connection. Provide an electrical junction box with terminal strip for motor and other electrical terminations. The factory mounted terminal wiring strip consists of a multiple position screw terminal block to facilitate wiring terminations for the electric control valves and thermostats.
2. Provide a hinged electrical enclosure in the bottom of the unit for easy access to all electrical components, terminal blocks and wiring.

K. Piping Packages:

1. Provide a standard factory assembled valve piping package to consist of a two way control valve and two ball isolation valves. Control valves shall be provided by temperature control contractor and shipped to FCU manufacturer for factory installation. Maximum entering water temperature on the control valve is 200°F, and maximum close-off pressure is 50 PSIG (1/2") or 25 PSIG (3/4"). Maximum operating pressure shall be 300 PSIG.
2. Provide pressure-temperature ports, strainers, and union connections for all piping packages.
3. Piping package shall be completely factory assembled, including interconnecting pipe, and shipped separate from the unit for field installation on the coil, so as to minimize the risk of freight damage.

L. Controls Package:

1. FCU Manufacture to provide, install and wire any and all controls required to accomplish the FCU sequence of operation specified under "Central Control and Monitoring Systems" section unless specifically indicated to be provided by the controls system contractor per the following table:

Control Device	Supplied By	Installed By	Wired By
DDC Controller	Controls Contractor	FCU Manufacturer	FCU Manufacturer
Space Sensor	Controls Contractor	Controls Contractor	Controls Contractor
FCU Speed Switch	Controls Contractor	Controls Contractor	Controls Contractor
Control Valves	Controls Contractor	FCU Manufacturer	Controls Contractor
Discharge Air Sensor	Controls Contractor	FCU Manufacturer	FCU Manufacturer
Control Transformer	FCU Manufacturer	FCU Manufacturer	FCU Manufacturer
Fan Speed Isolation Relays	FCU Manufacturer	FCU Manufacturer	FCU Manufacturer
Drain Pain Float Switch	FCU Manufacturer	FCU Manufacturer	FCU Manufacturer
Controller Enclosure	FCU Manufacturer	FCU Manufacturer	Not Applicable

Notes:

- 1) Installation shall include mounting, wiring and terminations.
- 2) FCU shall be made completely ready for field termination of space sensor, speed switch and control valves.
- 3) Control devices specified to be provided by controls contractor but installed by manufacturer shall shipped direct to manufacturer for factory installation
- 4) FCU controller shall be field programmed by controls contractor.
- 5) Manufacturer to wire controls system per wiring diagram provided by controls contractor.

2.36 CONDENSATE RETURN UNIT:

- A. The condensate return unit shall be a Bell & Gossett Domestic Series CC Duplex or approved equal of the type, arrangement, size, and indicated capacities and characteristics.
- B. Condensate receiver
  1. The condensate receiver shall be of close grained cast iron construction (warranted for 20 years from the date of shipment against failure due to corrosion).
  2. The receiver shall offer maximum protection from corrosion and feature an inlet, vent and overflow opening to provide a means of secondary venting.
  3. The receiver shall be furnished with one, externally adjustable, NEMA 1, two-pole, float switch for pump control of Simplex unit. Duplex units shall be furnished with two, externally adjustable NEMA 1, two-pole switches for pump control.
  4. The receiver may have provisions for future addition of second pump, when provided as a Simplex Unit.
- C. Water pump
  1. The water pump shall be a Series C35 or C17 bronze fitted centrifugal design pump, close-coupled to 3500 RPM motor, permanently aligned, and flange mounted for vertical operation.
  2. Each pump shall include:
    - a) One cast Iron volute with one discharge gauge port tapping and one drain tapping.
    - b) One dynamically balanced enclosed bronze centrifugal impeller.
    - c) One renewable bronze wearing ring.
    - d) One stainless steel shaft.



- e) Carbon/ceramic/Buna mechanical seal suitable for 250°F (121°C) operation.
  - 3. Each pump shall be sized for two times the system return rate.
  - 4. Each motor shall meet NEMA specifications with wetted portion stainless steel shaft, Open Drip Proof enclosure type (Totally Enclosed Fan-Cooled or Explosion Proof) and shall be the size, voltage, insulation class, duty rating and enclosure called for in the plans.
  - 5. Capacities and electrical characteristics for the pump shall be scheduled on the drawings.
- D. Pump shall be included with the following options:
- 1. Water level gauge glass for visual tank level inspection.
  - 2. A dial thermometer
  - 3. A NEMA 1 automatic mechanical alternator to replace two float switches.
  - 4. Consolitol® NEMA 2, UL electrical panel, mounted and wired with drip lip and piano hinged door is available with the following options:
    - a) Magnetic starters with thermal overload protection / one per pump.
    - b) One fused control circuit transformer when the motor voltage exceeds 250V.
    - c) “Auto-Off-Hand” selector switch / one per pump.
    - d) Pump running pilot light / one per pump.
    - e) Auxiliary contact on the magnetic starter normally open for remote monitoring of pump operation / one per pump.
    - f) One single point power connection for duplex units.
    - g) One electrical alternator for duplex units with float switches.
    - h) Control power switching relay shall allow the switch over of control power from one pump to the other in duplex units in the event of a power failure or pump failure.
    - i) Liquid tight conduit suitable for NEMA 2 applications.

## 2.37 PUMPS:

- A. Provide Bell & Gossett pumps or approved equal (see Section 23 00 10) of types, sizes, capacities, and characteristics as scheduled on the Equipment Schedule drawings. Ensure pump operation at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer. The pump NPSH shall confirm to the ANSI/HI 9.6.1-1997 standards for *Centrifugal and Vertical Pumps for NPSH Margin*. Ensure pump pressure ratings are at least equal to system’s maximum operating pressure at point where installed, but not less than specified.
- B. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned, and shall be realigned after installation by the manufacturer’s representative. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications and conform to the standards outlined in EPACT 92.

C. End Suction Long Coupled Pump (Base Mounted):

1. Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow removal and service of the entire rotating assembly without disturbing the pump piping, electrical motor connections or pump to motor alignment.
2. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The impeller shall be a cast stainless steel enclosed type, balanced to ANSI/HI 9.6.4-2009 balance grade G6.3 and secured to the shaft by a locking capscrew or nut.
3. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F (107°C). A replaceable stainless steel shaft sleeve shall completely cover the wetted area under the seal.
4. Pump shall be rated for minimum of 175 psi (12 bar) working pressure. Volute shall have gauge tapings at the suction and discharge nozzles and vent and drain tapings at the top and bottom. The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2009 for recommend acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2009 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.
5. Baseplate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff as to limit the susceptibility of vibration. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.8.2.1-2009 for grouted Horizontal Baseplate Design standards.
6. A flexible type, center drop-out design coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupling sleeve. The coupling shall be shielded by a dual rated ANSI B15.1 & OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling.
7. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the contractor per factory recommendations after installation.

2.38 SPLIT HEAT PUMP UNIT

- A. General: The outdoor condensing unit is designed specifically for use with matched capacity SkyAir series indoor evaporator units.
1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a Daikin swing compressor, motors,

- fans, condenser coil, electronic expansion valves, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, service ports and suction accumulator.
2. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
  3. The outdoor unit can be wired and piped in the front, lateral or downward directions, accessed from the right side of the unit.
  4. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit.
  5. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.
  6. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
  7. The following safety devices shall be included on the condensing unit; high pressure switch, outdoor fan driver overload protector, inverter overload protector, fusible plugs, fuses.
  8. Each condensing unit shall utilize an algorithm to automatically adjust the refrigerant suction and condensing temperatures in response to the cooling loads, and in response to the current weather conditions. The VRT control shall be capable of being customized in the following modes and sub modes:
    - a) Automatic (factory preset) – The Automatic VRT control shall allow the target evaporator temperature (Te) and target condensing temperature (Tc) to float based on outdoor ambient temperature conditions, and shall incorporate the following sub-modes:
      - Powerful
      - Quick
      - Mild (factory preset)
    - b) High Sensible – The High Sensible mode shall allow the system Te and Tc values to be programmed to series of fixed Te and Tc values. The High Sensible mode shall also be capable of incorporating the following sub-modes:
      - Eco
    - c) Basic – The Basic mode shall disable the VRT control of the outdoor unit and allow the system to operate with constant Te and Tc values.

B. Unit Cabinet:

1. The outdoor unit model RZR\_\_TAVJU shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
2. The outdoor unit will come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to a cement pad or optionally supplied mounting bracket.

C. Fan:

1. The condensing unit shall consist of one propeller type, direct-drive 200W fan motor that has multiple speed operation via a DC (digitally commutating) inverter.
2. The fan shall be a horizontal discharge configuration with a nominal airflow maximum of 2,682 cfm.
3. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
4. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
5. Condenser Coil:
6. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
7. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure highly efficient performance.
8. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube.
9. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1 rated for up to 1000 hours salt spray.
10. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

D. Compressor:

1. The Daikin swing compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed swing type.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
5. The compressor shall be mounted to avoid the transmission of vibration.

## 2.39 WALL MOUNTED DUCTLESS UNIT

### A. General:

1. Daikin indoor unit model FAQ shall be a wall mounted fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. It shall be connected to the corresponding SkyAir series outdoor condensing unit. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC2A71, BRC1E73 and BRC7E818. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 37 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.

### B. Indoor Unit:

1. The Daikin indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The front grille shall be easily removed for washing. The drain pipe can be fitted to from either left or right sides.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through the a resin net mold resistant filter.
5. The indoor units shall be equipped with a condensate pan.
6. The indoor units shall be equipped with a return air thermistor.
7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
8. The voltage range will be 253 volts maximum and 187 volts minimum.

### C. Unit Cabinet:

1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output of 43 W.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

E. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 14 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 1/16 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.
6. A condensate pan shall be located in the unit.

F. Electrical:

1. A separate power supply will be required of 208-230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet.
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

G. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. A full array of fault diagnostics shall be accessible via the remote controller.
3. The unit shall be compatible with interfacing with connection to BACnet and LonWorks networks or interfacing with connection to BMS system. Consult with Daikin prior to applying controls.
4. The unit shall be compatible with a Daikin Intelligent touch Manager advanced multi-zone controller.

2.40 FBQ INDOOR UNIT – DUCTED CONCEALED UNIT

A. General:

1. Daikin indoor unit model FBQ shall be a ducted concealed fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion

valve, for installation in the ceiling. It shall be connected to the corresponding SkyAir series outdoor condensing unit. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8" from the drain pipe opening. The indoor units sound pressure shall range from 37 dB(A) to 38 dB(A) at low speed measured 5 feet below the ducted unit with 6.6 ft of discharge ductwork and 3.3 ft of suction ductwork.

B. Indoor Unit:

1. The Daikin indoor unit FBQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be individually insulated from the outdoor unit.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return air openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipment with an automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output of 350 Watts.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.

6. The fan motor shall be equipped as standard.
7. Fan motor external static pressure range for nominal airflow:

Model Number	Fan ESP (in. WG)
FBQ18PVJU	0.80 – 0.20
FBQ24PVJU	0.80 – 0.20

E. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 15 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 18-3/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

F. Electrical:

1. A separate power supply will be required of 208-230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

G. Control:

1. The unit shall be compatible with a Wired or Wireless I/R controller to perform input functions necessary to operate the system.
2. A full array of fault diagnostics shall be accessible via the remote controller.
3. The unit shall be compatible with interfacing with connection to BACnet and LonWorks networks or interfacing with connection to BMS system. Consult with Daikin prior to applying controls.

H. Optional Accessories Available:

1. Remote "in-room" sensor kit (KRCS01-4B)
  - a) The Daikin wall mounted, hard wired remote sensor kit is recommended for applications where there could be a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).



2.41 DUPLEX CONDENSATE UNIT:

- A. Provide a Hoffman Specialty Watchman Series WC Duplex condensate pumping unit manufactured by Bell & Gossett or approved equal (see Section 23 00 10) of the type, arrangement, size, and indicated capacities and characteristics.
- B. Duplex condensate pumping unit shall consist of:
  - 1. One (1) cast iron receiver
  - 2. Two (2) water pumps
  - 3. Float actuated pump switch as hereafter specified.
  - 4. Each unit shall be factory tested.
- C. Cast Iron Receiver
  - 1. The condensate receiver shall be closed grain cast iron construction warranted for 20 years from date of shipment against failure due to corrosion.
  - 2. Receiver shall be equipped with:
    - a) 2 NPT Inlet
    - b) 2 NPT Vent
    - c) Receiver shall be sized for 1-minute net storage based upon system return rate.
    - d) Receiver shall have overflow opening to provide a means of secondary venting all on a common side of the receiver.
- D. Pump control
  - 1. Duplex Unit One - (1) externally adjustable mechanical alternator to automatically alternate operation of the two pumps and provide simultaneous operation of both pumps to deliver double capacity under peak conditions.
- E. Pumps
  - 1. The centrifugal pumps shall be flanged mounted on the receivers.
  - 2. Pump(s) shall be so constructed to permit access to the impeller and other interior parts without break in the discharge pipe connections.
  - 3. Pumps shall be:
    - a. close coupled vertical design
    - b. bronze fitted
    - c. permanently aligned
    - d. stainless steel shaft
    - e. enclosed bronze impeller
    - f. renewable bronze wear ring

g. carbon/ceramic mechanical shaft seal shall be rated for 250°F (121 °C)

F. Motors

1. Each pump shall be closed coupled to a vertical drip proof motor.
2. Motor(s) shall be:
  - a. 3500 RPM single phase
  - b. 115/230 volt
  - c. factory wired for 115 volts
  - d. field convertible to 230 volts
  - e. Motor shall have internal thermal overload protection

2.42 VARIABLE AIR VOLUME (VAV) TERMINAL UNITS:

- A. Provide Trane VAV units or approved equal (see Section 15010) of the type, arrangement, size, and indicated capacities and characteristics. Unit performance data shall be rated in accordance with ARI Standard 880. Single and dual duct terminal units shall be UL listed as an entire assembly.
- B. VAV units shall be ceiling mounted primary air control terminal units for connection to a single medium - 1.5-3.0 in. wg. pressure duct of a central air distribution system. Terminals units shall be provided with integral heating coils. Identify each terminal unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory-set air flow, minimum factory-set air flow, and coil type.
- C. Units shall be completely factory-assembled, manufactured of corrosion protected steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the terminal unit damper and 22-gauge metal on the low pressure (outlet) side and unit casing.
- D. 1" Double-wall Insulation: The interior surface of the unit casing is acoustically and thermally lined with a 1-inch, 1.0 lb./ft<sup>3</sup> (25.4 mm, 16.0 kg/m<sup>3</sup>) composite density glass fiber with high-density facing. The insulation R-value is 3.85. The insulation is UL listed and meets NFPA-90A and UL 181 standards. An interior liner made of 26-gauge galvanized steel covers the insulation. All wire penetrations are covered by grommets. There are no exposed edges of insulation (complete metal encapsulation).
- E. Locate primary air control damper assembly inside unit casing. Construct the damper assembly from extruded aluminum and/or a minimum 20 gauge galvanized steel components. Maximum damper leak rate shall not exceed 1% of damper nominal CFM at 4 inch wg. differential. Provide damper assembly with integral flow sensor. Flow sensor shall be a multi-point, averaging, ring or cross type.
- F. The hot water reheat coil shall be factory-installed on the discharge outlet. The coil shall have 144 aluminum-plated fins per foot. The 3/8" OD seamless copper tubes shall be mechanically expanded into the fin collars. Coils shall be proof tested at 450 psig and leak tested at 300 psig air pressure under water. Coil connections shall be as indicated on the drawings.

- G. Direct digital controls (DDC) shall be supplied by Building Automation System Contractors to VAV Box Manufacture for factory installation. Field mounted DDC Controls are not acceptable. Terminal unit manufacturer shall provide and factory install an electric 24 VAC 3-wire floating control damper actuator.

#### 2.43 SMOKE CONTROL FANS CONTROL:

- A. All fans, dampers, and other HVAC equipment that are part of a smoke control system shall be monitored and controlled by a U.L Listed Fire Fighters' Smoke Control Panel (FSCP) in accordance with NFPA 92. The FSCP Shall be manufactured by Alerton. The FSCS size and capacity shall be as required by the number of smoke control points. The station shall be located in the fire command center. The FSCP shall comply with building code requirements and NFPA 92 guidelines.
- B. Stair pressurization fan shall be provided with a duct smoke detector in the airstream to de-energize the fan upon detection of smoke. A red indicator, with reset switch, labeled "smoke detector trip" shall be located on the face of the firefighter's smoke control panel adjacent to the Fan's manual override switch. The duct detector shall be furnished by the electrical contractor, mounted by the mechanical contractor and power wired by the electrical contractor.
- C. Stair pressurization fan shall be provided with a motorized damper on the discharge side of the fan. Damper shall be fully open prior to emerging fan. On the inlet side of the fan provide a 45' cowling with 1'x1" galvanized steel screen covering the entire inlet.
- D. Smoke control fan shall be UL Listed.
- E. Smoke control fans shall be controlled by differential pressure sensors every 3 floors near the supply air grille shown on the riser diagrams. Differential pressure shall be controlled at a minimum of 0.10" and shall not exceed 0.35" at any sensor.

### PART 3 - EXECUTION

#### 3.1 DUCTWORK, GENERAL:

- A. Drawings show general arrangement of duct. Provide all ductwork required to complete installation and avoid interferences. Installation shall conform with applicable portions of Section 23 00 10, General Provisions, HVAC. Fabricate ducts as job progresses, using actual job measurements and referring to architectural, structural, electrical, plumbing and equipment drawings in order to avoid conflicts. Where space limitations preclude use of ducts and fittings as shown, consult Engineer for instructions. All ductwork, offsets, fittings, etc. required to make a complete and efficiently operating installation are included in this contract and shall be fabricated and installed in accordance with SMACNA Standards for the application unless noted otherwise herein.
- B. All duct dimensions shown on drawings are "inside clear". The sizes of acoustically lined ducts and dampers in ducts shall be increased accordingly. Ducts shall be smooth on inside.

- C. Provide flexible duct connectors at all ductwork connections to equipment with fans, motors or rotating components.
- D. Install double thickness turning vanes in duct fittings having centerline radius less than 1-1/2 times width of duct.
- E. Support ducts from building structure with 1 inch wide galvanized steel bands per SMACNA recommendations. Wire hangers and nylon straps will not be acceptable.
- F. Do not install runout drops to ceiling diffusers until ceiling grids have been installed. Center ceiling diffusers between grids.
- G. Provide a locking quadrant balancing damper at each supply takeoff fitting and each exhaust takeoff fitting, for balancing individual diffusers and grilles.
- H. Seal all joints in supply, return and exhaust ducts with Childers CP-145 Veloseal, or McGill Airseal, DuroDyne or equal water based synthetic duct sealant, or equal.
- I. 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 system with all control devices wide open.

### 3.2 FIRE DAMPERS:

- A. Fire dampers shall be securely anchored to floor or wall, and installed by bolting retaining angles to the sleeve on each side of the wall. Wall and floor penetrations shall be fire sealed with an approved UL listed firestop system as manufactured by 3M, Hilti, Metacaulk or equal for the wall or floor type penetrated. A suitable access door shall be provided for each fire damper. In accordance with the requirements of the International Building Code, contractor shall permanently mark any access doors or other openings that serve as a means of access to fire dampers with 1/2" letters reading "Fire Damper". Label shall be permanently and securely attached.

### 3.3 PIPING, GENERAL:

- A. All piping shall conform with Section 23 00 10 - General Provisions - HVAC.
- B. Provide a flange or union in screwed or welded pipe where pipe connects to equipment. At control valves, install union in each pipe connecting to the device. Screwed unions shall not be installed where they will be subjected to bending stresses, as in expansion loops or offsets.
- C. Provide flexible pipe connectors at all piping connections to pumps.
- D. Run pipes parallel to walls and ceilings. Wherever pipes change size, use eccentric fittings. Run piping so as not to obstruct walking or service areas.

- E. Pipe and equipment locations shown are approximate. Exact location of equipment, pipes, and chases to be as approved and determined in field to avoid other pipes and maintain structural clearances. Use actual job dimensions and equipment shop drawings for roughing.
- F. Piping to comply with best trade practice. Provide clearance between pipe and building structure so pipes can expand without damage to building structure.
- G. Install manual air vents at all high points in piping system and 1/2" drain valves at all low points in piping system.
- H. Pipe water relief drains, blowdown, and other drains to, but not into, the most convenient floor drain or where otherwise directed.
- I. When soldering refrigerant pipe joints, a dry nitrogen purge shall be required through the inside of the pipe to prevent oxidation.

#### 3.4 CONDENSATE DRAINS:

- A. Pipe evaporator condensate drains into nearest floor drain, roof drain, gutter or as indicated. Piping shall be routed to avoid interference with passageways or maintenance.
- B. Drains shall be trapped to overcome air handler static pressure.
- C. Drain piping shall be sloped 1/8" per foot.
- D. Drain piping shall be sized as follows

<b>EQUIPMENT CAPACITY</b>	<b>MINIMUM CONDENSATE PIPE DIAMETER</b>
Up to 20 tons of refrigeration	$\frac{3}{4}$ inch
Over 20 tons to 40 tons of refrigeration	1 inch
Over 40 tons to 90 tons of refrigeration	1 $\frac{1}{4}$ inch
Over 90 tons to 125 tons of refrigeration	1 $\frac{1}{2}$ inch
Over 125 tons to 250 tons of refrigeration	2 inch

#### 3.5 CHEMICAL WATER TREATMENT:

- A. After hydrostatic pipe testing the closed loop heating, cooling, and condenser water system shall be pre-treated and post-treated to clean the pipe system and provide corrosion resistance.
- B. For initial cleaning, air handlers, coils and heat exchanger shall be isolated. Provide a liquid alkaline cleaner to clean the pipe systems. Cleaner shall be circulated for 8 hours minimum. Bleed and feed water until the total dissolved solids <500 uS/cm, the pH <7.8, and there is no visible color or suspended soils. Clean all strainers open all valves and circulate water for one hour. Flush all water from system.

- C. For final treatment provide sufficient scale and corrosion inhibitor immediately after flushing.
- D. Contractor to provide a one year service plan to include quarterly monitoring and necessary treatment as required.

3.6 EQUIPMENT, GENERAL:

- A. All equipment specified herein shall be installed in accordance with manufacturer's published installation instructions and these specifications. All items shall have adequate clearances for access and maintenance. Each item of equipment shall be performance tested to verify compliance with specifications. Certified data sheets of successful performance tests shall be included in operating manuals.

3.7 SUBMITTALS:

- A. Provide submittals as required in Section 23 00 10. At completion of work, submit check-out report of automatic control system. Submit start up reports per Section 23 00 10. Submit test and balance report per 23 00 10. Submit manufacturer's installation, operation, and maintenance instructions.

End of Section 23 05 00

## SECTION 23 05 01 – AIR HANDLING UNIT

### PART 1 - GENERAL

#### 1.1 GENERAL REQUIREMENTS:

- A. Provide Daikin air handling units or approved equal, of the type, arrangement, size, and indicated capacities and characteristics.

#### 1.2 SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements. Computer generated fan curves for each air handling unit shall be submitted with specific design operating point noted. A computer generated psychometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted. Sound data for discharge, radiated and return positions shall be submitted by octave band for each unit. Calculations for required baserail heights to satisfy condensate trapping requirements of cooling coil shall be included.
- B. Product Data:
  - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, finishes of materials, electrical characteristics, and connection requirements.
  - 2. Provide data of filter media, filter performance data, filter assembly, and filter frames.
  - 3. Provide manufacturer's installation instructions.

#### 1.3 SAFETY AGENCY LISTED & CERTIFICATION

- A. Air Handling units shall be cETLus safety listed to conform with UL Standard 1995 and CAN/CSA Standard C22.2 No. 236. Units shall be accepted for use in New York City by the Department of Building, MEA 342-99-E.
- B. Air handler furnished with double width, double inlet (DWDI) fans and/or plenum fans where applicable, shall be certified in accordance with the central station air handling units certification program, which is based on AHRI Standard 430. (NOTE: Above does not apply to fan array)
- C. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on AHRI Standard 410.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. The following manufacturers are approved for use. No substitutions will be permitted.

1. Daikin Applied 'Vision' Air Handler shall be the basis of design.
2. Trane
3. Carrier
4. York

### 2.2 GENERAL DESCRIPTION

- A. Configuration: Fabricate as detailed on drawings.
- B. Performance: Conform to AHRI 430. See schedules on prints. (NOTE: above does not apply to fan array)
- C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

### 2.3 UNIT CONSTRUCTION

- A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
- B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
1. The inner liner shall be constructed of G90 galvanized steel.
  2. The outer panel shall be constructed of G90 galvanized steel.
  3. The floor plate shall be constructed as specified for the inner liner.
  4. Unit will be furnished with solid inner liners.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
- D. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5" w.c. in positive pressure sections and -6" w.c. in negative pressure sections (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure)
- E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.



- F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- G. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping. The base rail shall be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090.
- H. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3'' above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2'' thickness of insulation under drain pan.

## 2.4 FAN ASSEMBLIES

- A. Acceptable fan assembly shall be a single width, single inlet, class II, direct-drive type plenum fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes. Provide access to motor and fan assembly through hinged access door.
  - 1. Unit shall have two 9 blade direct drive class II fans.
  - 2. Manual block-off mounted upstream of fan for isolation of individual fans.
  - 3. Single source power motor control panel with short circuit protection factory wired from panel to motors in conduit shall be provided.
- B. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.

## 2.5 BEARINGS, SHAFTS, AND DRIVES

- A. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be provided on the motor with the fan wheel mounted directly on the motor shaft, AMCA arrangement 4.
- B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
- C. The fan wheel shall be direct coupled to the motor shaft. The wheel width shall be determined by motor speed and fan performance characteristics.

## 2.6 ELECTRICAL

- A. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPA requirements), 1750 RPM, single speed, 200V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
- B. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
- C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
- D. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
- E. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.
- F. Air handler manufacturer shall provide, mount and wire variable speed drive with electrical characteristics such as indicated on project schedule and shown on manufacturer's data sheets.

## 2.7 COOLING AND HEATING COILS

- A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
- B. Water cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
  - 1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
  - 2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the

- entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
  4. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up.
  5. Coil casing shall be a formed channel frame of galvanized steel.
- C. Water heating coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
  2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
  3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
  4. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up.
  5. Coil shall be furnished as an uncased galvanized steel to allow for thermal movement and slide into a pitched track for fluid drainage.

## 2.8 FILTERS

- A. Furnish combination filter section with 2-inch pleated MERV 13 flat pre-filter and 12-inch Varicel SH cartridge final filter. Provide side loading and removal of filters.
- B. Filter media shall be UL 900 listed, Class I or Class II.

## 2.9 ADDITIONAL SECTIONS

- A. Mixing box section shall be provided with end outside air opening and top return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Connecting linkage and ABS plastic end caps shall be provided when return and outside air dampers are each sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

## PART 3 - EXECUTION

### 3.1 NOT USED

End of Section 23 05 01

## SECTION 23 05 02 – DEDICATED OUTDOOR AIR UNIT

### PART 1 - GENERAL

#### 1.1 GENERAL REQUIREMENTS:

- A. Provide Daikin dedicated outdoor air units or approved equal, of the type, arrangement, size, and indicated capacities and characteristics.

#### 1.2 SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements. Computer generated fan curves for each air handling unit shall be submitted with specific design operating point noted. A computer generated psychometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted. Sound data for discharge, radiated and return positions shall be submitted by octave band for each unit. Calculations for required baserail heights to satisfy condensate trapping requirements of cooling coil shall be included.
- B. Product Data:
  - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, finishes of materials, electrical characteristics, and connection requirements.
  - 2. Provide data of filter media, filter performance data, filter assembly, and filter frames.
  - 3. Provide manufacturer's installation instructions.

#### 1.3 SAFETY AGENCY LISTED & CERTIFICATION

- A. Air Handling units shall be cETLus safety listed to conform with UL Standard 1995 and CAN/CSA Standard C22.2 No. 236. Units shall be accepted for use in New York City by the Department of Building, MEA 342-99-E.
- B. Air handler furnished with double width, double inlet (DWDI) fans and/or plenum fans where applicable, shall be certified in accordance with the central station air handling units certification program, which is based on AHRI Standard 430. (NOTE: Above does not apply to fan array)
- C. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on AHRI Standard 410.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. The following manufacturers are approved for use. No substitutions will be permitted.
  - 1. Daikin Applied 'Skyline' Air Handler shall be the basis of design.
  - 2. Trane
  - 3. Carrier
  - 4. York

### 2.1 GENERAL DESCRIPTION

- A. Configuration: Fabricate as detailed on prints.
- B. Performance: Conform to AHRI 410 and 430 Standards. See schedules on prints. (NOTE: Above does not apply to fan array)
- C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

### 2.2 UNIT CONSTRUCTION

- A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
- B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
  - 1. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
  - 2. The inner liner shall be constructed of G90 galvanized steel.
  - 3. The floor plate shall be constructed as specified for the inner liner.
  - 4. Unit will be furnished with solid inner liners.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.

- D. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5" w.c. in positive pressure sections and -6" w.c. in negative pressure sections (.0025 m<sup>3</sup>/s per square meter of cabinet area at 1.24 kPa static pressure)
- E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
- F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- G. Provide cross broke roofcap system to divert water from the top surface of the air handler. The rain shed roofcap shall have 2" standing seams covered with splice cap channels to seal top seam. Splice cap shall break down over sides of standing seam to protect the ends of the seam.
  - 1. Cooling coil piping vestibule 30" deep shall be factory installed of standard cabinet construction on the coil connection side of the unit. Roofcap over vestibule shall be a continuous single piece covering both the coil section and the vestibule. Roofcap seams between coil section and vestibule are not allowed.
  - 2. Heating coil piping vestibule 30" deep shall be factory installed of standard cabinet construction on the coil connection side of the unit. Roofcap over vestibule shall be a continuous single piece covering both the coil section and the vestibule. Roofcap seams between coil section and vestibule are not allowed.
- H. The unit shall have a 6-inch curb ready base for structural rigidity and condensate trapping. The curb-ready base shall be designed with sloped drip pans located under all unit sections except duct openings and shall be supported by frame member.
- I. Roof curb kit of 16-inch height shall provide support for the air handler on the building roof and provide a weather protected area for terminating and securing the roof membrane. The roof curb kit shall be manufactured by the air handler unit manufacturer.
- J. An insulated, double-walled piping vestibule, 30" deep, shall be factory installed of standard cabinet construction on the coil connection side of the unit. Roofcap over vestibule shall be a continuous single piece covering both the coil section and the vestibule. Roofcap seams between coil section and vestibule are not allowed.
- K. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2" thickness of insulation under drain pan.

## 2.3 FAN ASSEMBLIES

- A. Provide ECM, motorized impeller fan(s). Fan assembly shall include fan, fan base, and a motor and shall be dynamically balanced by the fan manufacturer.
  - 1. Fan array shall be equipped with a piezometer point to measure airflow. One piezometer point shall be supplied on one fan in the fan array.
  - 2. Motor control panel shall come equipped with a fused disconnect.
  - 3. Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault.
  - 4. Motor shall be brushless DC type with a permanent magnet rotor.
  - 5. Fan section shall come equipped with a motor control panel mounted on the fan section. Both line voltage and low voltage wiring shall be done by the factory. Each fan shall have an isolation switch.
  - 6. Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.

## 2.4 BEARINGS, SHAFTS, AND DRIVES

- A. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

## 2.5 ELECTRICAL

- A. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
- B. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
- C. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
- D. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.

## 2.6 COOLING AND HEATING COILS

- A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
- B. Water cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with



coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
3. Coil tubes shall be OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
4. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up.
5. Coil casing shall be a formed channel frame of galvanized steel.

C. Water heating coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.

3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
4. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up.
5. Coil shall be furnished as an uncased galvanized steel to allow for thermal movement and slide into a pitched track for fluid drainage.

## 2.7 ENERGY RECOVERY WHEEL

- A. Provide enthalpy energy recovery wheel with minimum of 4 angstrom molecular sieve impregnated synthetic media. Wheel shall have minimum diameter of 72" and minimum depth of 6". Minimum total effectiveness shall not be less than 77% during summer conditions. Assembly shall be provided with VFD for speed control and frost prevention. Performance shall be rated in accordance with AHRI Standard 1060. Enthalpy wheel section shall include bypass damper for unoccupied recirculation operation.

## 2.8 FILTERS

- A. Furnish flat panel filter section with 4-inch filter. Provide side loading and removal of filters.
- B. Filter media shall be UL 900 listed, Class I or Class II.
- C. Filter Magnehelic gauge(s) shall be furnished and mounted by equipment manufacturer.

## 2.9 ADDITIONAL SECTIONS

1. Plenum section shall be provided and properly sized for inlet and/or discharge air flow (between 600 and 1500 feet per minute). The plenum shall provide single or multiple openings as shown on drawings and project schedule.
2. Access section shall be provided for access between components. Floor options shall include .125-inch aluminum treadplate or drain pan as shown on project schedule.

## PART 3 - EXECUTION

### 3.1 NOT USED

End of Section 23 05 02

## SECTION 23 05 48 - VIBRATION ISOLATION AND SEISMIC/WIND RESTRAINT

### PART 1 – GENERAL

- 1.1 The work in this section consists of furnishing engineering and materials necessary for vibration isolation and seismic/wind restraints for equipment contained herein for the project. All mechanical equipment 3/4 HP and over listed in the Vibration Isolation / Seismic schedule shall be mounted on vibration isolators to prevent the transmission of objectionable vibration and vibration induced sound to the building structure. All isolation materials, flexible connectors and seismic restraints shall be of the same manufacturer and shall be selected and certified using published or factory certified data. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner. The contractor and manufacturer of the isolation and seismic equipment shall refer to the isolator and seismic restraint schedule which lists isolator types, isolator deflections and seismic restraint type. Vibration isolators shall be selected in accordance with the equipment, pipe or duct weight distribution so as to produce reasonably uniform deflections.
- 1.2 Unless otherwise specified, all mechanical, and plumbing equipment, pipe, and duct shall be restrained to resist seismic and wind forces. Restraints shall maintain equipment, piping, and duct work in a captive position. Restraint devices shall be designed and selected to meet the seismic and wind loading requirements as defined in the latest issue of the IBC or local jurisdiction building code.
- 1.3 SEISMIC RESTRAINT SHALL NOT BE REQUIRED FOR THE FOLLOWING:
  - A. Hanging, wall mounted, and flexibly supported mechanical, plumbing and components that weigh 20 pounds (89 N) or less, where  $I_p = 1.0$  and flexible connections are provided between the components and associated duct work, piping and conduit.
  - B. Piping supported by individual clevis hangers where the distance, as measured from the top of the pipe to the supporting structure, is less than 12 inches (305mm) for the entire pipe run and the pipe can accommodate the expected deflections. Trapeze or double rod hangers where the distance from the top of the trapeze or support to the structure is less than 12 inches for the entire run. Hanger rods shall not be constructed in a manner that would subject the rod to bending moments (swivel, eye bolt, or vibration isolation hanger connection to structure).
  - C. High deformability piping (steel, copper, aluminum with welded, brazed, grooved, or screwed connections) designated as having an  $I_p = 1.5$  and a nominal pipe size of 1 inch or less where provisions are made to protect the piping from impact or to avoid the impact of larger piping or other mechanical equipment. Note, any combination of piping supported on a trapeze where the total weight exceeds 10 lb/ ft. must be braced.
  - D. High deformability piping (steel, copper, aluminum with welded, brazed, grooved, or screwed connections) and limited deformability piping (cast iron, FRP, PVC) designated with an  $I_p = 1.0$  and a nominal pipe size of 1 inch and less in the mechanical equipment room, or 2" and less outside the mechanical equipment room.

- E. PVC or other plastic or fiberglass vent piping.
- F. HVAC ducts suspended from hangers that are 12 inches or less in length from the top of the duct to the supporting structure and the hangers are detailed to avoid significant bending of the hangers and their connections. Duct must be positively attached to hanger with minimum #10 screws within 2" from the top of the duct.
- G. HVAC duct with an  $I_p = 1.5$  that have a cross-section area less than 4 square feet. HVAC ducts with an  $I_P = 1.0$  that have a cross sectional area of less than 6 square feet.
- H. Equipment items installed in-line with the duct system (e.g, fans, heat exchangers and humidifiers) with an operating weight less than 76 pounds. Equipment must be rigidly attached to duct at inlet and outlet.

#### 1.4 MANUFACTURER'S RESPONSIBILITIES:

- A. Manufacturer of vibration and seismic control products shall have the following responsibilities:
- B. Determine vibration isolation and seismic/wind restraint sizes and locations.
- C. Provide piping, ductwork and equipment isolation systems and seismic restraints as scheduled or specified.
- D. Provide installation instructions and shop drawings for all materials supplied under this section of the specifications.
- E. Provide calculations to determine restraint loads resulting from seismic and wind forces presented in local building code or IBC, Chapter 16 latest edition. Seismic/wind loading calculations shall be certified & stamped by an engineer in the employ of the seismic equipment manufacturer with a minimum 5 years experience and licensed in the project's jurisdiction. Provide calculations for all floor or roof mounted equipment, all suspended or wall mounted equipment 20lbs or greater, and vibration isolated equipment 20lbs or greater.
- F. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges.
- G. The seismic supplier shall provide a certificate of professional liability insurance for the seismic engineer for an amount not less than \$1,000,000.00.

#### 1.5 SUBMITTALS:

- A. Submit shop drawings of all isolators, seismic restraints and calculations provided. The manufacturer of vibration isolation products shall submit the following data for each piece of isolated equipment: clearly identified equipment tag, quantity and size of vibration isolators and seismic restraints for each piece of rotating isolated equipment. Submittals for mountings and hangers incorporating springs shall include free height, rated

deflections, and solid load. Submittals for bases shall clearly identify locations for all mountings as well as all locations for attachment points of the equipment to the mounting base. Submittals shall include seismic calculations signed and checked by a qualified licensed engineer in the employ of the manufacturer of the vibration isolators. Catalog cut sheets and installation instructions shall be included for each type of isolation mounting or seismic restraint used on equipment being isolated.

- B. Provide shop drawings indicating location of all specification SC cable restraints (section 2.3.2) required for pipe and ductwork. Drawings must be stamped by manufacturer's registered professional engineer.
- C. Mechanical, electrical and plumbing equipment manufacturers shall provide certification that their equipment is capable of resisting expected seismic loads without failure. Equipment manufacturers shall provide suitable attachment points and/or instructions for attaching seismic restraints.

## PART 2 - PRODUCTS

### 2.1 QUALITY CONTROL:

- A. The isolators and seismic restraint systems listed herein are as manufactured by Amber / Booth, Mason Industries, Kinetics, or approved equals which meet all the requirements of the specifications, are acceptable. Manufacturer must be a member of the Vibration Isolation and Seismic Control Manufacturers Association (VISCMA). Non-isolated seismic rated curbs by Imperial Metals are acceptable.
- B. Steel components shall be cleaned and painted with industrial enamel. All nuts, bolts and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer.
- C. All isolators, bases and seismic restraints exposed to the weather shall utilize cadmium plated, epoxy coat or PVC coated springs and hot dipped galvanized steel components. Nuts, bolts and washers may be zinc-electroplated. Isolators for outdoor mounted equipment shall provide adequate restraint for the greater of either wind loads required by local codes or withstand a minimum of 30 lb. / sq. ft. applied to any exposed surface of the equipment.

### 2.2 VIBRATION ISOLATORS:

- A. Specification W: Pad type mounting consisting of two layers of ribbed elastomeric pads with a 1/2" poro-elastic vibration absorptive material bonded between them. Pads shall be sized for approximate deflection of 0.10" to 0.18". Pads shall be Amber / Booth Type NRC.
- B. Specification D: Elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, 30 degree rod misalignment and an elastomeric isolation element designed for approximately 1/2" deflection. Hangers shall be Amber/Booth Type BRD.

## 2.3 SEISMIC RESTRAINTS:

- A. Specification SC: Restraint assembly for suspended equipment, piping or ductwork consisting of high strength galvanized steel aircraft cable. Cable must have Underwriters Laboratories listed certified break strength, and shall be color-coded for easy field verification. Secure cable to structure and to braced component through bracket or stake eye specifically designed to exceed cable restraint rated capacity. Cable must be manufactured to meet or exceed minimum materials and standard requirements per AISI Manual for structural applications of steel cables and ASTM A630. Break strengths must be per ASTM E-8 procedures. Safety factor of 1.5 may be used when prestretched cable is used with end connections designed to meet the cable break strength. Otherwise safety factor 3.76 must be used. Cables shall be sized for a force as listed in section 1.3. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation. Restraint shall be Amber/Booth Type LRC.

## 2.4 ROOFTOP UNIT CURBS AND ISOLATION SYSTEMS:

- A. Specification X: Non-isolated seismically rated rooftop curb system that is flashed into roofing membrane. Air and watertight curb shall have a neoprene sponge seal at the top and be rigid enough to provide continuous perimeter support for rooftop unit. Curb must provide means to positively anchor to concrete deck, or bolt or weld directly to structural steel to withstand seismic loading. Curb shall provide a means by which contractor supplied insulation may be installed for thermal insulation and acoustic attenuation. Curbs shall accommodate roof pitch shown on drawings. Curb shall use minimum 18 gage galvanized steel and shall be designed with crossbracing required to withstand the greater of seismic forces (para 1.3.) and/or wind loading per local building code. Design must be certified by registered professional engineer in the employ of the manufacturer. Seismic curbs shall be Amber/Booth Type RTC. Seismic equipment rails shall be Imperial Metals Model MR-NC, 18" high.

## 2.5 FLEXIBLE PIPE CONNECTIONS:

- A. Specification K: Water Service:
1. For flanged connection – a double sphere arch rubber expansion joint constructed of molded reinforced neoprene with integral steel floating flanges, and designed to be suitable for pressures up to 225 PSI (4 to 1 safety factor) and temperatures up to 225 degrees F. Connectors shall have minimum movement capabilities of 1.77" compression, 1.18" lateral and 1.18" extension. Connectors shall provide a minimum 35 degree angular movement up to 6", minimum 30 degree up to 12" and minimum 20 degree up to 24". Spring loaded control units shall be furnished to limit movement to within allowables. Flex connector shall be Amber/Booth Type 2600.
  2. For threaded type – A double spherical rubber hose connector, minimum 8" long, constructed of molded neoprene, nylon cord reinforced, with female pipe unions each end. Connectors shall have a minimum movement capability of 7/8" compression, 7/8" lateral, 1/4" extension and 20 degree angular through 1-1/4", 13 degree through 2", and 9 degree through 3". Connectors shall be suitable for a

maximum working pressure (4 to 1 safety factor) of 150 psi and 225 degree F. Connectors shall have cable control units to limit extension to 1/4". Flex connector shall be Amber/Booth Type 2655.

B. Specification L: Steam and Condensate Service:

1. For flanged connection – a metal hose connector constructed of stainless steel hose and braid with carbon steel plate flanges. Live lengths shall conform to hose minimum length to absorb thermal and dynamic movement. Hose axis must be perpendicular to pipe movement. Flex connector shall be Amber/Booth Type SS-FP or SS-FW.
2. For threaded connections - a metal hose connector constructed of stainless steel hose and braid with carbon steel NPT threaded end fittings. Flex connector shall be Amber/Booth Type SS-PM.

PART 3 – EXECUTION

- 3.1 Isolator and seismic restraints shall be installed as recommended by the manufacturer. Isolate all mechanical equipment 3/4 hp and over per the isolation schedule and these specifications.

3.2 PIPING ISOLATION:

- A. Install full line size flexible pipe connectors at the inlet and outlet of each pump, cooling tower, condenser, chiller, coiling connections and where shown on the drawings. All connectors shall be suitable for use at the temperature, pressure, and service encountered at the point of installation and operation. End fitting connectors shall conform to the pipe fitting schedule. Control rods or protective braid must be used to limit elongation to 3/8". Flexible connectors shall not be required for suspended in-line pumps.
- B. Horizontal Pipe Isolation: All HVAC pumped water, steam, pumped condensate, glycol, and refrigerant piping size 1 1/4" and larger connected to isolated equipment shall be isolated for the first 3 support locations from externally isolated equipment with specification E hangers or specification SB or SX floor mounts with the same deflection as equipment isolators (max 2").
- C. Pipe Riser Isolation: All variable temperature vertical pipe risers 1-1/4" and larger, riser piping requiring isolation per para. 3.2.1 or where specifically shown and detailed on riser drawings shall be fully supported by specification B mounts with precompression plates. Steel spring deflection shall be .75 inch minimum except in those locations where added deflection is required due to pipe expansion and contraction. Spring deflection shall be a minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Pipe risers up through 16" shall be supported at intervals of every third floor of the building. Pipe risers 18" and over, every second floor. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Horizontal take-offs and at upper and lower elbows shall be supported with spring isolators as required to accommodate anticipated movement. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be

submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist if installed per design proposed. Riser supports shall be Amber/Booth Type SWP.

### 3.3 INSTALLATION:

- A. Comply with manufacturer's instructions for the installation and load application of vibration isolation materials and products. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary support during installation or shipping. Locate isolation hangers as near the overhead support structure as possible. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
- B. Install isolated inertia base frames and steel bases on isolator units as indicated so that a minimum of 1 inch clearance below base will result when supported equipment has been installed and loaded for operation.
- C. Seismic rated roof curbs shall be installed directly to building structural steel or concrete roof deck. Upon approval by structural engineer curbs may sit directly on top of the steel deck. Installation on top of roofing material is not acceptable. Shimming of seismic rated curbs is not allowed.
- D. Housekeeping Pads shall be constructed and installed per ASHRAE's "A Practical Guide to Seismic Restraint". They shall be a minimum of .5" thicker than the maximum embedment required of any anchor but not less than 6". They shall be sized to provide minimum edge distances for all installed anchors. They must be anchored to the floor structure in an approved manner.
- E. Concrete anchor locations shall not be near edges, stress joints, or an existing fracture. All anchor bolts to steel shall be ASTM A307 or better

### 3.4 APPLICATION OF SEISMIC RESTRAINTS:

- A. Isolated Equipment:
  - 1. All floor mounted isolated equipment shall be protected with type SB or type C unitized isolator and restraint or with separate type SL restraints (minimum of 4) in conjunction with type B isolators. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
  - 2. All suspended isolated equipment and vessels shall be protected with specification SC restraints. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation.



B. Rigidly Mounted Equipment:

1. Floor mounted equipment shall be protected by properly sized anchor bolts with elastomeric grommets provided by the isolation manufacturer. Suspended equipment shall be protected with type SC bracing.

C. Piping:

1. All piping not exempted shall be protected in all planes by type SC restraints, designed to accommodate thermal movement as well as restrain seismic motion. (spring-loaded control rods should be used on flexible connectors in system). Tanks and vessels connected inline to piping shall be restrained independently. Locations shall be as determined by the isolator/seismic restraint supplier, and shall include, but not be limited to: (1) At a proximity to protect all drops to equipment connections and (2) At changes in direction of pipe as required to limit over stressing of pipe or movement that contacts other building material. (3) At horizontal runs of pipe, not to exceed the spacing as presented in Amber/Booth design criteria. (4) SMACNA design criteria.
2. Where riser pipes pass through cored holes, core diameters to be a maximum of 2" larger than pipe O.D. including insulation. Cored holes must be packed with resilient material or firestop as provided by other sections of this specification or local codes. No additional horizontal seismic bracing is required. Restrained isolators type C or SB shall support risers and provide longitudinal restraint at floors where thermal expansion is minimal and will not bind isolator restraints. For risers in pipe shafts, specification type SC cable restraints shall be installed at each level in a manner that does not interfere with thermal movement.

D. Duct Work:

1. Duct work 6 square feet and larger in cross sectional area (4 sq. ft. for systems with  $I_p=1.5$ ) shall be protected in all planes by type SC restraints. Locations shall be determined by the isolator supplier and shall include, but not be limited to: (1) at equipment connections as required to protect the connections. (2) at all duct runs and duct run ends (transverse bracing and longitudinal bracing not to exceed spacing specified in Amber/Booth design criteria, or SMACNA guidelines).

End of Section 23 05 48

## SECTION 23 07 00 – HVAC INSULATION

### PART 1 - GENERAL

#### 1.1 WORK INCLUDED:

- A. General Requirements: This section shall include all insulation as required for installation on all items as specified hereinafter and/or as indicated. All insulations shall be installed in a workmanlike manner by qualified workers in the employment of an independent insulation contractor. Costs of insulation shall be included as part of work by contractor as applicable to his section of work. No separate bid is to be included for insulation work.
- B. Fire hazard classification for all material shall not exceed flame spread of 25 and smoke development of 50 as classified by Underwriters Laboratories under Test Method ASTM E-84 and acceptable under NFPA Standards. This is to apply to the complete system and be a composite rating of insulation material with jacket or facings, vapor barrier, joint sealing tapes, mastic and fittings.
- C. Prior to commencing any work, submit data sheets for engineer's approval of all material proposed to be used on this project.

### PART 2 - PRODUCTS

#### 2.1 ABOVE GROUND INDOOR PIPING:

- A. Pipe Insulation:
  - 1. All water piping shall be insulated with heavy density fiberglass with all-service jacket equal to Owens-Corning Double Self-Sealing Lap, ASJ/SSL-II, one piece, to be used on all lines above and below ambient temperature from 0°F to 850°F.
- B. Refrigerant Pipe Insulation:
  - 1. Insulation material shall be a flexible, closed-cell elastomeric insulation in tubular form equal to AP Armaflex, or Aerocell, or FlexTherm. This product meets the requirements as defined in ASTM C 534, "Specification for preformed elastomeric cellular thermal insulation in tubular form." Insulation materials shall have a closed-cell structure to prevent moisture from wicking which makes it an efficient insulation. Insulation material shall be manufactured without the use of CFC's, HFC's or HCFC's. It is also formaldehyde free, low VOC's, fiber free, dust free and resists mold and mildew.
  - 2. Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ASTM E 84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.

3. Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft<sup>2</sup>- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision.
4. When supported with uni-strut an insulation sleeve under the clamp is required equal to Armacell Armafix, Aerocell Aerofix, or Cooper B-Line.

C. Condensate Drain Insulation:

1. Use Armacell AP Armaflex, or equal, in a thickness adequate to maintain an insulation surface temperature of 84°F. Miter elbows and seal with adhesive. Coat all joints with Childers CP-30 LO or CP-35 WB Vapor Barrier Coatings, or equal. Use only indoors.

2.2 JACKET FOR EQUIPMENT ROOM PIPING:

- A. All insulated piping in equipment rooms shall be covered with eight (8) ounce cotton canvas manufactured in the United States. All hot water piping shall be lagged with Childers CP-9, CP-10 or CP-11 Weather Barrier Coating, or equal. All chilled water piping shall be lagged with Childers CP-30 LO Solvent thinned Vapor Barrier Coating or CP-35 Water Based Vapor Barrier Coating, or equal.

2.3 ABOVE GROUND EXTERIOR PIPING:

- A. All exterior piping insulation shall be Foamglas as manufactured by Pittsburg Corning or equal, jacketed with aluminum jacketing.

2.4 JACKET FOR OUTDOOR PIPING:

- A. All insulation outside (including insulation options) shall be protected with corrugated aluminum jacketing with factory applied moisture barrier. The aluminum jacketing shall be 0.016 thickness and be of 3003 alloy and H-14 temper. Jacketing shall be applied with 2-inch circumferential and 1-1/2 inch longitudinal lap and secured with 3/8 inch wide aluminum bands, 8 inches on center.
- B. All elbows shall be covered with 2 piece aluminum insulation covers, manufactured from 110 aluminum alloy in .024" thickness, Childers Aluminum E11-Jacs or equal.
- C. On hot service, aluminum elbows may be attached using self-tapping screws. On chilled water service, aluminum elbows shall be glued on pipe insulation.

## 2.5 PIPE INSULATION THICKNESS:

- A. Piping for the following systems shall be insulated to the thickness listed:

<u>Item</u>	<u>Insulation Thickness (Inches)</u>
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Cold Pipes:

Chilled Water (Supply & Return)

Pipe up to 1-1/2"	1-1/2"
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Pipe 2" and above	2"
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Condensate Drain Piping	1/2"
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Refrigerant Suction	3/4"
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Refrigerant Liquid (TXV in outdoor unit)	1/2"
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Hot Pipes:

Steam and Condensate

Pipe up to 1-1/2"	2"
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Pipe 2" and above	3"
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Hot Water (Heating Supply & Return)

Pipe up to 1-1/2"	1-1/2"
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Pipe 2" and above	2"
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## 2.6 DUCTWORK INSULATION:

- A. Supply, Return, and Fresh Air Return Ducts in Equipment Rooms:

1. Insulation shall be 1-1/2 inch thick board equal to Owens Corning 705 (FRK) (ASJ).

- B. Low Pressure Supply and Return Ducts 5 Feet From Air Handling Equipment:

1. Line all metal ducts with closed-cell elastomeric insulation, 1 inch thick duct liner equal to Armacell AP Armaflex FS. Liner shall meet requirements of ASTM C1338, G21 and G22 with respect to resistance to microbial growth.

C. Return Transfer Ducts and Sound Elbows on Grilles:

1. Line all metal ducts with 1-1/2 pound density, 1 inch thick duct liner equal to Owens Corning Aeroflex PLUS. Liner shall meet requirements of ASTM C1338, G21 and G22 with respect to resistance to microbial growth.

D. Supply, Return, and Fresh Air Ducts:

1. Insulate all, including lined and double wall spiral, metal ducts with 2" thick, 3/4 pound density duct wrap with FRK vapor barrier equal to Owens Corning Fiberglas All Service Duct Wrap.

E. Duct Insulation (Flexible, Internal):

1. Where indicated on plans line all metal ducts with 1" thick Armaflex closed cell foam insulation or equal.

F. Plenums and Casing Insulation (Internal):

1. All plenums and casings shall be internally lined with 3.0 pound density, 1-1/2 inch thick duct liner equal to Owens Corning Aeroflex PLUS. Liner shall meet requirements of ASTM C1338, G21 and G22 with respect to resistance to microbial growth.

2.7 OUTDOOR DUCT INSULATION:

A. DOAS Supply and Exhaust Ducts:

1. Insulate all sheet metal duct work outdoors exposed to the weather with 2 inch thick Owens-Corning 705 insulation board or equal with FSK factory applied facing. Seal all joints of metal duct with Childers CP-145A prior to installing insulation.

2.8 JACKET FOR OUTDOOR DUCTWORK:

- A. All insulation outside shall be protected with stucco embossed aluminum jacketing with factory applied moisture barrier. The aluminum jacketing shall be 0.024 thickness and be of 3003 alloy and H-14 temper. Polyfilm Moisture Barrier (PFMB) is an engineered three-layer coextruded film of polyethylene and Surlyn\* polymers with a total film thickness of 3 mils that is heat laminated in the factory to the interior surface of aluminum jacketing.

2.9 EQUIPMENT INSULATION:

A. Hot Vessels (to 400°F)

1. Hot tanks and vessels operating at temperatures not over 400°F shall be insulated with the thickness of insulation board as outlined below. Insulation board shall be pre-formed, flat rectangular rigid material. Maximum K value shall be .24 at 75°F mean temperature.

2. All vessels storing fluids, or connected to systems containing fluids, at temperatures between 150°F to 400°F shall be insulated.

<u>Equipment</u>	<u>Insulation Thickness</u>
Expansion Tank and Air Release Tank	1"
Heat Exchanger	2"
Condensate Receiver	2"
Hot Water Pumps	1-1/2"

B. Cold Vessels:

1. Cold vessels shall be insulated with foam plastic sheet, nominal 5 pound density, k factor .28 maximum at 75°F mean, 0.17 permeance, flame spread 25 or less, temperatures 40°F to 200°F.

<u>Equipment</u>	<u>Insulation Thickness</u>
Expansion Tank & Air Release Tank	3/4"
Chilled Water Pumps	3/4"
Fan Coil Unit Drain Pans	1/2"

### PART 3 - EXECUTION

#### 3.1 PIPE INSULATION:

- A. All insulation shall be applied to clean, dry surfaces butting all sections firmly together and finishing as specified hereinafter.
- B. All vapor barriers shall be sealed, and shall be continuous throughout. No staples shall be used on any vapor barrier jacket unless sealed with vapor barrier coating or vapor barrier tape.
- C. Insulation of all insulated lines shall be interpreted as including all pipe, valves, fittings and specialties comprising the lines, except flanged unions and screwed unions on hot piping.
- D. Valves and unions on chilled water piping shall have oversized insulation applied and sealed with CP-30 LO or CP-35 or equal.
- E. Where sectional insulation is not practical, the proper insulation cement or block insulation shall be utilized by forming it to the applied surface.

- F. Pipe Insulation Protection: Direct contact between pipe and hangers shall be avoided. Hanger shall pass outside of a sheet metal protection saddle which shall cover a section of high density insulation (cellular glass or calcium silicate), of sufficient length to support the weight of the pipe without crushing the insulation. The vapor barrier shall be continuous behind the saddle or shall be lapped over the saddle and securely cemented thereto.
- G. Flow measurement: Provide a removable section of insulation for each pump at location designated by the engineer. Removable section shall be approximately 18 inches long and shall consist of two (2) 1/2" layers of Armaflex, or equal, with staggered joints. Insulation shall be held in place by three (3) Velco straps and be fully removable and replaceable without disturbing adjacent pipe insulation. All joints shall retain vapor seal integrity.
- H. All pipe covering shall be furnished with self-seal lap and 3" wide butt joint strips. The release paper is pulled from adhesive edge, pipe covering closed tightly around pipe and self-seal lap rubbed hard in place with the blunt edge of an insulation knife. This procedure applied to longitudinal as well as circumferential joints. Staple all longitudinal and circumferential joints with 9/16" staples 6" on center and seal over all staples with Childers CP-30 or equal vapor barrier coating. Care shall be taken to keep jacket clean as it is the finish on all exposed work. All adjoining insulation sections shall be firmly butted together before butt joint strip is applied, and all chilled water and cold water service lines shall have vapor barrier coating thoroughly coated to pipe at butt joints and at all fittings. All fittings, valve bodies, unions, and flanges shall be finished as follows:
  - 1. To the hot insulated fittings, apply a tack coat of Childers CP-10 or CP-11 (use CP-35 on cold piping) or equal at the rate of 2 gallons per 100 S.F. While the tack coat is still wet, a layer of 10 x 10 fiberglass reinforcing mesh shall be embedded with all fabric seams overlapped a minimum of 2". A finish coat, at a coverage rate of 4 gallons per 100 S.F. shall be applied, fully covering the reinforcing mesh.
  - 2. Apply fiberglass inserts to all other hot fittings and cold water fittings in conjunction with Proto PVC Fitting Covers. Seal cold applications as recommended by the manufacturer.
- I. Refrigerant Tubing and Condensate Drain Pipe Insulation: Armaflex insulation shall be slip fit over all tubing. Under no circumstances shall insulation be slit to fit over pipe already in place. Sufficient length shall be provided at all bends or turns to prevent the insulation from being pulled too tight and cracking. All seams and butt joints shall be adhered and sealed using Armaflex 520 or 520 BLVAdhesive or equal. Direct contact between pipe and hangers shall be avoided. Hanger shall pass outside of a sheet metal protection saddle which shall cover a section of high density insulation (cellular glass or calcium silicate), of sufficient length to support the weight of the pipe without crushing the insulation. The vapor barrier shall be continuous behind the saddle or shall be lapped over the saddle and securely cemented thereto.

### 3.2 APPLICATION VERTICAL VESSELS AND PIPE GREATER THAN 35" O.D.:

- A. Insulation shall be furnished with a factory applied ASJ facing.

- B. For application to piping and vessels operating between 0°F. and 55°F., apply a minimum 3" wide ASJ matching tape over the joints for proper vapor seal.
- C. For application to piping and vessels operating between -50°F. and 0°F., apply a bead a CP-76 joint sealant before applying a minimum 3" wide ASJ matching tape over the joint for proper vapor seal.

### 3.3 ALUMINUM JACKET:

- A. Jacketing shall be applied with 2-inch circumferential and 1-1/2 inch longitudinal lap and secured with 3/8 inch wide aluminum bands, 8 inches on center and at joints.

### 3.4 FLEXIBLE TUBING:

- A. Pipe surface must be clean, dry and free from any contaminates. Apply insulation in accordance with manufacturer's published recommendations at ambient temperatures of 40°F or above.

### 3.5 DUCTWORK INSULATION:

#### A. Board Insulation (External):

- 1. Board shall be applied by means of resistance welded mechanical fasteners or equal. Pins shall not be less than 3 inches in from each edge or corner of board and no more than 12 inches on center. Cut side pieces of insulation to lap top and bottom and scribe board to fit irregular surfaces. Apply a three inch wide bank of Childers CP-30 LO or CP-35 Vapor Barrier Coating or equal on all joints of insulation. While tack coat is still wet, embed 3-inch wide White 10 x 10 Fiberglass reinforcing mesh and recoat fully covering the mesh. Pins shall not protrude excessively above fastening washers. Spot all washers with Childers CP-30 LO or equal and cover with material to match jacket.

#### B. Flexible Insulation (External):

- 1. Application: Insulation shall be wrapped tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped to the bottom of the rectangular duct. On ductwork over 24 inches wide, secure insulation with suitable resistance welded mechanical fasteners at not more than 18 inches on center. The 2-inch flange on the facing shall be stapled with 9/16 inch flare door stainless steel staples on 6 inch centers. Apply a three inch wide bank of Childers CP-30 LO or CP-35 or equal Vapor Barrier Coating on all joints of insulation. While tack coat is still wet, embed 3-inch wide White 10 x 10 Fiberglass reinforcing mesh and recoat fully covering the mesh. Spot all pin penetrations or punctures in the insulation with a full coat of CP-30 LO or CP-35 or equal.

#### C. Flexible Insulation (Internal):

- 1. Applications: Duct Liner shall be applied to the interior of metal ducts using Armaflex Low VOC Spray Adhesive or an equal product having a flame spread of



less than 25 and a smoke development of less than 50 and classified such by Underwriters Laboratories.

2. When duct height or plenum walls exceed 24 inches and when duct widths exceed 12 inches, resistance welded mechanical fasteners will be used in addition to duct liner adhesive. Fasteners shall start within 3 inches of the upstream transverse edges of the liner and 3 inches from the longitudinal joints. Fasteners should be spaced a maximum of 6 inches on center around the perimeter of the duct, except that they may be a maximum of 6 inches from a corner break. Elsewhere they shall be a maximum of 18 inches on center.
3. Insulation shall extend the full length of each duct section to permit butting firmly at the duct joints. All joints shall be tightly sealed with Armaflex 520 or 520 BLVAdhesive or equal.

D. Plenums and Casing Insulation (Internal):

1. Insulation shall be applied to sheet metal surfaces which have been wiped clean and dry in the following manner:
2. Fasten insulation to sheet metal with coated surface facing the airstream side of the duct using Childers CP-121 HV Duct Liner Adhesive or equal. Additionally, secure liner with mechanical fasteners in accordance with Plate 2 of SMACNA "Duct Liner Standards". Coat all joints with Childers CP-135 CHIL-SPRED sealer or equal.
3. Apply a 1/2 inch mesh galvanized wire 16 gauge (.063) over the entire surface of the board and secure with speed washers.

3.6 OUTDOOR DUCT INSULATION:

- A. Insulation board shall be applied by means of resistance welded mechanical fasteners 12 inches on center and secured with a full coat of Childers CP-85 CHIL-STIX Clear UL Classified Adhesive or equal. Pins shall not be less than 3 inches in from each edge or corner of board. Cut side pieces of insulation to lap top and bottom, and scribe board to fit irregular surfaces. Pins shall protrude 1/8 to 3/16 inch above insulation. Apply Childers CP-76 Sealant (about the size of a pea) under the washer before pressing it down.
- B. Apply a tack coat of Childers CP-10/11 or equal to the outside of the duct at a rate of 2 gallons to 100 S.F. While the coating is still wet, embed into it a layer of CHIL-GLAS 5 (5 x 5 weave) or equal. Apply a finish coat at a rate of 4 gallons per 100S.F. fully covering the fiberglass reinforcing mesh., so that the minimum dry film thickness is 1/16 inch. Follow manufacturer's "Suggested Application Procedures" on data sheet.
- C. (Cold Ducts):
  1. After the VI-CRYL CP-10/11 or equal coating has dried completely, apply a uniform coat of Childers ENCACEL V or ENCACEL X or equal vapor barrier coating at a coverage rate of 6 gallons per 100 S.F.

### 3.7 EQUIPMENT INSULATIONS:

#### A. Equipment Insulation for Hot Vessels (to 400°F)

1. Insulation shall be cut and mitered where necessary to fit the contour of the vessel. For round vessels, insulation shall be banded in place with 1/2 inch x .020 stainless steel bands 18" on center. For flat or irregular vessels, insulation shall be impaled over weld pins and secured with speed washers. Apply a smoothing coat of One Shot Cement.
2. Apply metal lathe over the insulation, lacing edges on round vessels and securing to the weld pins with speed washers on flat and irregular vessels. Apply 1/2 inch coat of One Shot Cement and let thoroughly dry before applying finishing mastic.
3. Apply a tack coat of Childers CP-10/11 Vinyl Acrylic Mastic or equal on hot vessels by brush. Embed a layer of Childers CHIL-GLAS 5 (5 x 5 weave) or equal reinforcing mesh into wet coating, smoothing to avoid wrinkles. A finish coat at a coverage of 4 gallons per 100 S.F. shall be applied fully covering the reinforcing mesh so that the minimum dry film thickness is 1/16 inch.

#### B. Kitchen Range and Boiler Breeching:

1. Insulation block shall be secured to channel with 16 gauge stainless steel wire attached to anchors. Insulation shall be given two 1/4 inch coats of One Shot Finishing Cement with the first coat applied over galvanized hexagonal wire. The second coat shall be mixed 2 to 1 with Portland Cement or equal. Doors shall be insulated as above with framing angles around doors.

#### C. Equipment Insulation for Cold Vessels:

1. Application:
  - a) Insulation shall be cut and mitered where necessary to fit the contour of the vessel. Cover the area of the size of one foamed plastic sheet with Rubatex Adhesive No. 373 or equal. Cover the back of the flexible sheet with the same, leaving 1/2 inch wide uncoated border around the outside edge. Let the adhesive dry to the touch before applying. Align sheet to overlap edges of the sheets in place by 1/8". Then press center of the sheet to adhere. Pressure butt edges into place for a tight joint. Roll the rest of the sheet for firm adhesion to surface. Spread the butt joints with a small brush, coat the edges and align for good appearance. Stagger all joints as applicable to horizontal or vertical installation. Do not fill the butt joints with adhesive. If painting is required, use two (2) even coats of Rubatex Mastic No. 374 (white), or equal, colored for desired purposes. Wipe the sheet with a cloth dampened with a non-oily solvent to remove powder before painting.

- b) Apply a tack coat of Childers CP-30 LO or CP-35 or equal on cold vessels by brush. Embed a layer of Childers CHIL-GLAS 5 (5 x 5 weave) or equal reinforcing mesh into wet coating, smoothing to avoid wrinkles. A finish coat at a coverage of 4 gallons per 100 S.F. shall be applied fully covering the reinforcing mesh so that the minimum dry film thickness is 1/16 inch.

D. Pumps:

- 1. Insulation shall be fitted (boxed) around the water pumps so as to include the pump volute, the bearings and the portion of the base under the volute and bearings.
- 2. The upper portions of the insulating box, above the centerline of the pump shaft, shall be made up as a separate and easily removable box to permit access to the pump and bearings. The box shall be made up of #22 gauge galvanized sheet steel.

E. Fan Coil Drain Pans:

- 1. Insulate underside and sides of main drain pans with all edges sealed with CP-30 or equal. Insulation shall be applied to a dry drain pan with Armstrong adhesive or equal.

F. Chiller Water Boxes:

- 1. The removable heads and water boxes of the chiller shall be covered with a four section galvanized steel box, lined with glass rigid equipment insulation impaled over weld pins and secured with speed washers. The four sections shall be bolted together with 1/4" bolts on 6-inch centers through and outstanding flange.

End of Section 23 07 00

## SECTION 230800 - COMMISSIONING OF HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
  - Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

#### 1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Pre-Functional Test Checklists and equipment start up reports

#### 1.5 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase commissioning kick-off meeting.
- C. Attend construction phase controls coordination meetings.
- D. Attend testing, adjusting, and balancing review and coordination meetings.
- E. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

- F. Provide information requested by the CxA for final commissioning documentation.
- G. Provide measuring instruments and logging devices, calibrated within one year of date of test unless specifications or industry standards require more stringent calibration periods, to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

#### 1.6 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Organize Contractor provided test data, inspection reports, and certificates in Systems Manual.

#### 1.7 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
  - 1. Plan for delivery and review of submittals, operation and maintenance manuals, and other documents and reports.
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
  - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
  - 6. Test and inspection reports and certificates.
  - 7. Corrective action documents.
  - 8. Verification of testing, adjusting, and balancing reports.

#### PART 2 - PRODUCTS (Not Used)

#### PART 3 - EXECUTION

##### 3.1 TESTING PREPARATION

- A. Provide a fully executed Certificate of Readiness signed by Contractor, Subcontractors, TAB Agent and BAS provider certifying that HVAC&R Systems, instrumentation and control systems have been completed and calibrated, pre-tested and inspected and that they are operating according to the Contract Documents, and that pretest set points have been recorded. Provide completed Certificate of Readiness to CxA no less than 7 days prior to the scheduled beginning of on-site CxA verification testing.
- B. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.
- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.2 TESTING, ADJUSTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 30 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
- D. The CxA will notify testing, adjusting and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
  - 1. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 2. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
  - 3. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

### 3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space.
- C. Cx Testing of systems and equipment shall include measuring capacities and effectiveness of operational and control functions in addition to or in conjunction with any statutory and regulatory testing required by Authorities Having Jurisdiction over the project and testing required in other Sections of this Project Manual.
- D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- E. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- F. Tests will be performed using design conditions whenever possible.

- G. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- H. The CxA may direct that set points be altered when simulating conditions is not practical.
- I. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- J. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

#### 3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation And Control For HVAC." Assist the CxA with preparation of testing plans.
- B. Refrigerant System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- C. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of special exhaust; and other distribution systems, including HVAC&R terminal equipment, dedicated outdoor air delivery and heat recovery equipment and unitary equipment.
- D. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

**END OF SECTION 230800**

## SECTION 23 09 00 – CENTRAL CONTROL AND MONITORING SYSTEM

### 1. PART 1 – GENERAL

#### 1.1 Related Documents

- A. All work of this Division shall be coordinated and provided by the single Central Control and Monitoring System (CCMS) Contractor.
- B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.
- C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

#### 1.2 Scope of Work

- A. This section includes the controls, instrumentation and associated piping and wiring required to make the mechanical systems provided under Division 23 perform as described in these specifications and as shown. Provide a complete system of automatic temperature control of the direct digital type. The system shall be complete in all respects including all labor, materials, equipment, and service necessary, and shall be installed by personnel in the direct employ of the manufacturer. Provide a distributed process network control system complete with all necessary hardware and software including all programming. The new DDC systems for the new Byrnes Hall shall be compatible with the existing Clemson campus wide control system network in all respects. The existing control system network is Johnson Controls Metasys.
- B. Utilize the existing CMMS server for the purpose of providing a location for archiving system configuration data, graphics and historical data such as trend data and operator transactions.
- C. Provide a complete and operational Central Control and Monitoring System (CCMS) including all devices and software necessary to perform the functions herein described or indicated on the drawings.
- D. The CMMS shall be a Web based system communicating over the building owners Local Area Network (LAN). Contractor shall be responsible for coordination with the owner's IT staff to ensure that the CMMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN. TCP/IP connections and addresses shall be provided by the owner for connection of supervisory panels to the Clemson network..
- E. The primary desktop and laptop interface will be via a standard Web Browser such as Internet Explorer or Netscape. CMMS contractor shall provide software license(s) for CMMS WEB access for a minimum of twenty concurrent users.
- F. The primary focus of the Central Control and Monitoring System (CCMS) will be to monitor and control the new HVAC system components, air handling units, fans, heat exchangers, coils, valves, pumps, variable speed drives, etc. The system shall be expandable to serve future equipment, systems, and auxiliary field devices.



- G. CCMS contactor shall provide all DDC panels, power supplies, wiring, conduit, solenoid valves, relays, differential pressure transmitters, differential pressure switches, RTDS, pressure sensors, etc. necessary for a complete and operable automatic control system and DDC field panels and connecting LAN.
- H. The systems engineering phase shall include the selection and integration of components into a complete system which will meet the performance and prescriptive requirements of the Contract, together with drawings, specifications, descriptions of operation, diagrams including system architecture and other materials listed under "Submittals" paragraph of this Section. The successful contractor shall be responsible for all systems engineering.

### 1.3 Quality Assurance

- A. Quality assurance for automatic control systems includes a multi-step program consisting of a pre-qualification procedure for manufacturer and installation specialist; a system engineering, products and shop drawing phase; installation; testing and adjusting; reporting; commissioning testing and verifications; operating instruction and training; and the submission of maintenance and operating manuals.
- B. CMMS Contractor
  - 1. The Central Control and Monitoring System (CMMS) herein specified shall be fully integrated and installed as a complete package by the Central Control and Monitoring System contractor. The System shall include all wiring, piping, installation supervision, calibration, adjustments, and checkout necessary for a complete and fully operational system.
  - 2. The CMMS Contractor shall be a factory owned branch office that is regularly engaged in the engineering, programming, installation and service of CMMSs of similar size and complexity. Bids by wholesalers, mechanical contractors, franchised dealers, applied partners or any other firm whose principal business is not that of manufacturing and installing automatic temperature control systems shall not be acceptable.
  - 3. The CMMS Contractor shall have a minimum of ten years experience with the complete, turnkey installation of CMMSs of similar size and technical complexity.
  - 4. The CMMS shall be complete in all respects and shall be provided, installed and commissioned by the CMMS equipment manufacturer. Equipment manufacturer shall be responsible for and warrant the proper installation and operation of the CMMS and control system equipment.
  - 5. The following CMMS contractors are approved to provide and install the CMMS for this project subject to their ability to meet all requirements of this specification:  
  
Johnson Controls, Inc  
14 Woodcross Drive  
Columbia, SC 29212
  - 6. Bid approval does not imply nor suggest compliance of specification requirements.
- C. CMMS Products Manufacturer:
  - 1. The CMMS architecture shall consist of the products of a manufacturer regularly engaged in the production of CMMSs, and shall be the manufacturer's latest

standard of design. Controllers and DDC (Direct Digital Control) system components shall be current production products.

2. All other equipment shall be the products of the CMMS manufacturers or of an approved manufacturer regularly engaged in production of specialized CMMS materials or equipment.
3. Following is a list of acceptable CMMS products manufacturers:

Johnson Controls, Inc  
14 Woodcross Drive  
Columbia, SC 29212

4. Bid approval does not imply nor suggest compliance of specification requirements.

#### 1.4 Work Included and Interface Requirements

##### A. Installation of Central Control and Monitoring System (CMMS)

1. The CMMS contractor shall provide all necessary hardware and software to integrate the new control system with the existing Clemson campus CMMS. Integration means the ability to monitor, override, change set points, and provide real-time bi-directional dynamic data exchange between the new control system and the existing CMMS hardware and software.
2. The existing Clemson campus CMMS is a Johnson Controls Metasys system. The CMMS is comprised of multiple supervisory controllers, monitoring and communicating with various building control systems over the Clemson campus Ethernet LAN system. The new building control system will be connected to, and communicate with, the existing campus CMMS server via the Clemson campus Ethernet LAN
3. All new control points, monitoring points and software points shall be added to the existing Clemson CMMS database and shall be available for monitoring and adjustment at any computer, with current copy of Microsoft Internet Explorer software (Release 6.0 or later), that is connected to the Clemson LAN.
4. All new building software and databases shall be archived on the hard drive at the Clemson CMMS server. In the event that any building controller should lose its program that controller's archived software program shall be downloaded across the CMMS network from the CMMS server to the respective building controller.
5. The CMMS contractor will provide all necessary hardware, software, and labor to allow communication with all any computer, with current copy of Microsoft Internet Explorer (Release 6.0 or later), that is connected to the Clemson LAN.
6. Integrity of the existing CMMS shall be maintained during installation.
7. The new building control system shall be compatible in every respect with existing Metasys CMMS hardware and software. All new controllers shall be compatible with Metasys database and Metasys software development tools

## 1.5 Submittals

### A. Shop Drawings, Product Data, and Samples

1. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
2. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
3. The CCMS Contractor shall correct any errors or omissions noted in the first review.
4. At a minimum, submit the following:
  - a. CCMS network architecture diagrams including all nodes and interconnections.
  - b. Systems schematics, sequences and flow diagrams.
  - c. Points schedule for each point in the CCMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
  - d. Samples of Graphic Display screen types and associated menus.
  - e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
  - f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
  - g. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
  - h. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
  - i. Details of all CCMS interfaces and connections to the work of other trades.
  - j. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

## 1.8 Record Documentation

### A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the CCMS provided:
  - a. Table of contents.
  - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
  - c. Manufacturers product data sheets or catalog pages for all products including software.

- d. System Operator's manuals.
  - e. Archive copy of all site-specific databases and sequences.
  - f. CCMS network diagrams.
  - g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

## 1.9 Warranty

### A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the CCMS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the CCMS Contractor at the cost of the CCMS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during CCMS Contractor's normal business hours.

## 2. PART 2 – PRODUCTS

### 2.1 General Description

- A. The Central Control and Monitoring System (CCMS) shall use an open architecture. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- B. The Central Control and Monitoring System shall consist of the following:
  1. Standalone Network Automation Engine(s)
  2. Field Equipment Controller(s)
  3. Input/Output Module(s)
  4. Local Display Device(s)
  5. Distributed User Interface(s)
  6. Network processing, data storage and communications equipment
  7. Other components required for a complete and working CCMS
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

## 2.2 CCMS Architecture

### A. Automation Network

1. The CCMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Utilize existing application and data server as required for systems operation.
2. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
3. Network Automation Engines (NAE) shall reside on the automation network.
4. The automation network will be compatible with other campus-wide networks. Where indicated, the automation network shall be connected to the campus network and share resources with it by way of standard networking devices and practices.

### B. Control Network

1. Network Automation Engines shall provide supervisory control over the control network.
2. Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network
4. Wireless communication between DDC controllers is acceptable. All sensors shall be wired.

### C. Distributed Web Based User Interface

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. Alarms
  - a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
    - 1 Log date and time of alarm occurrence.
    - 2 Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.
    - 3 Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
    - 4 Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail

- shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
    - 5 Provide the capability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
    - 6 Any attribute of any object in the system may be designated to report an alarm.
  - b. The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
3. Reports and Summaries
- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
    - 1 All points in the CCMS
    - 2 All points in each CCMS application
    - 3 All points in a specific controller
    - 4 All points in a user-defined group of points
    - 5 All points currently in alarm
    - 6 All points locked out
    - 7 All CCMS schedules
    - 8 All user defined and adjustable variables, schedules, interlocks and the like.
  - b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
  - c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
  - d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
  - e. Energy Essentials Software: Provide a focused set of reports that includes essential information required for effective management of energy resources. Required includes but shall not be limited to:
    - Energy Overview
    - Load Profile
    - Simple Energy Cost
    - Consumption
    - Equipment Runtime
    - Electrical Energy
    - Energy ProductionReports shall be selectable by date, time, area and device. Each report shall include a graphical color visual summary of essential energy information.
4. Schedules
- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
    - 1 Weekly schedules

- 2 Exception Schedules
  - 3 Monthly calendars.
  - b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
  - c. It shall be possible to define one or more exception schedules for each schedule including references to calendars
- 5. Password
  - a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
  - b. A minimum of five levels of access shall be supported individually or in any combination as follows:
    - 1 Level 1 = View Data
    - 2 Level 2 = Command
    - 3 Level 3 = Operator Overrides
    - 4 Level 4 = Database Modification
    - 5 Level 5 = Database Configuration
    - 6 Level 6 = All privileges, including Password Add/Modify
  - c. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- 6. Dynamic Color Graphics
  - a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
  - b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
- 7. Historical trending and data collection
  - a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
    - 1 Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
      - Defined time interval
      - Upon a change of value
    - 2 Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
  - b. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
- 8. Trend data viewing and analysis
  - a. Provide a trend viewing utility that shall have access to all database points.

- b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
- c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
- d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
- e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
- f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
- g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

## 2.3 Network Automation Engines (NAE)

### A. Network Automation Engine (NAE)

- 1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
- 2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
- 3. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
- 4. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
- 5. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
- 6. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
  - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
  - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.



## 2.4 DDC System Controllers

### A. Field Equipment Controller (FEC)

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
2. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
3. The FEC shall be assembled in a plenum-rated housing with flammability rated to UL94-5VB.
4. The FEC shall include a removable base to allow pre-wiring without the controller.
5. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
6. The FEC shall support the following types of inputs and outputs:
  - a. Universal Inputs - shall be configured to monitor any of the following:
    - 1 Analog Input, Voltage Mode
    - 2 Analog Input, Current Mode
    - 3 Analog Input, Resistive Mode
    - 4 Binary Input, Dry Contact Maintained Mode
    - 5 Binary Input, Pulse Counter Mode
  - b. Binary Inputs - shall be configured to monitor either of the following:
    - 1 Dry Contact Maintained Mode
    - 2 Pulse Counter Mode
  - c. Analog Outputs - shall be configured to output either of the following:
    - 1 Analog Output, Voltage Mode
    - 2 Analog Output, current Mode
  - d. Binary Outputs - shall output the following:
    - 1 24 VAC Triac
  - e. Configurable Outputs - shall be capable of the following:
    - 1 Analog Output, Voltage Mode
    - 2 Binary Output Mode
7. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
  - a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
  - b. The FC Bus shall support communications between the FECs and the NAE.
  - c. The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
  - d. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
  - e.
8. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
  - a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
  - b. The SA Bus shall support a minimum of 10 devices per trunk.

- c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- 9. The FEC shall support, but not be limited to, the following:
  - a. Hot water, chilled water/central plant applications
  - b. Built-up air handling units for special applications
  - c. Terminal units
  - d. Special programs as required for systems control

## 2.5 Field Devices

### A. Input/Output Module (IOM)

- 1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
- 2. The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.

### B. Networked Thermostat (TEC)

- 1. The Networked Thermostats shall be capable of controlling the following:
  - a. A four pipe fan coil system with multi-speed fan control.
  - b. A two pipe fan coil with a single speed fan.
  - c. The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
- 2. The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
  - a. Two line, 8 character backlit display
  - b. LED indicators for Fan, Heat, and Cool status
  - c. Five (5) User Interface Keys
    - 1 Mode
    - 2 Fan
    - 3 Override
    - 4 Degrees C/F
    - 5 Up/Down
- 3. The Networked Thermostats shall provide the flexibility to support the following inputs:
  - a. Integral Indoor Air Temperature Sensor
  - b. Duct Mount Air Temperature Sensor
  - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator.
  - d. Two configurable binary inputs
- 4. The Networked Thermostats shall provide the flexibility to support the following outputs:
  - a. Three Speed Fan Control
  - b. On/Off Control
  - c. Floating Control
  - d. Proportional (0 to 10V) Control

C. VAV Modular Assembly (VMA)

1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
2. The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
3. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
4. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
5. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
6. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
7. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
8. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
9. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
10. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
11. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
12. Control set point changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of set point changes and to provide consistent operation in the event of communication failure.
13. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
14. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
15. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow set points.

16. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
  - 1 Absolute temperature loop error.
  - 2 Signed temperature loop error.
  - 3 Absolute airflow loop error.
  - 4 Signed airflow loop error.
  - 5 Average damper actuator duty cycle.
17. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
  - 1 Unreliable space temperature sensor.
  - 2 Unreliable differential pressure sensor.
  - 3 Starved box.
  - 4 Actuator stall
  - 5 Insufficient cooling.
  - 6 Insufficient heating.

The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
18. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.
19. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
20. Inputs:
  - a. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
    - 1 0-10 VDC Sensors
    - 2 1000ohm RTDs
    - 3 NTC Thermistors
  - b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
  - c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
  - d. Provide side loop application for humidity control.
21. Outputs
  - a. Analog outputs shall provide the following control outputs:
    - 1 0-10 VDC
  - b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

- c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
- 22. Application Configuration
  - a. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.
- 23. Sensor Support
  - a. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
  - b. The VMA shall support an LCD display room sensor.
  - c. The VMA shall also support standard room sensors as defined by analog input requirements.
  - d. The VMA shall support humidity sensors defined by the AI side loop.
- D. Network Sensors (NS)
  - 1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
    - a. Zone Temperature
    - b. Zone humidity
    - c. Zone set point
  - 2. The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
  - 3. The Network Sensors shall include the following items:
    - a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Set point.
    - b. An LED to indicate the status of the Override feature.
    - c. A button to toggle the temperature display between Fahrenheit and Celsius.
    - d. A button to initiate a timed override command
  - 4. The NS shall be available with either screw terminals or phone jack.
  - 5. The NS shall be available in either surface mount or wall mount styles.

## 2.6 Input Devices

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

2. Room Temperature Sensors
  - a. Room sensors shall be constructed for either surface or wall box mounting.
  - b. Room sensors shall have the following options when specified:
    - 1 Set point reset slide switch providing a  $\pm 3$  degree (adjustable) range.
    - 2 Individual heating/cooling set point slide switches.
    - 3 A momentary override request push button for activation of after-hours operation.
3. Thermo wells
  - a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
  - b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
  - c. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
  - d. Thermo wells shall be constructed of 316 stainless steel.
4. Outside Air Sensors
  - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
  - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
  - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
5. Duct Mount Sensors
  - a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
  - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
  - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
6. Averaging Sensors
  - a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
  - b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
  - c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
7. Acceptable Manufacturers: Johnson Controls, Setra.
- C. Humidity Sensors
  1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.

2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealite fittings and stainless steel bushings.
5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
7. Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.

D. Differential Pressure Transmitters

1. General Air and Water Pressure Transmitter Requirements:
  - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
  - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
  - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
  - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
2. Low Differential Water Pressure Applications (0" - 20" w.c.)
  - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
  - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - 1 .01-20" w.c. input differential pressure range.
    - 2 4-20 mA output.
    - 3 Maintain accuracy up to 20 to 1 ratio turndown.
    - 4 Reference Accuracy: +0.2% of full span.
  - c. Acceptable Manufacturers: Setra and Mamac.
3. Medium to High Differential Water Pressure Applications (Over 21" w.c.)
  - a. The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
    - 1 Differential pressure range 10" w.c. to 300 PSI.

- 2 Reference Accuracy:  $\pm 1\%$  of full span (includes non-linearity, hysteresis, and repeatability).
  - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
  - c. Acceptable Manufacturers: Setra and Mamac.
4. Building Differential Air Pressure Applications (-1" to +1" w.c.)
  - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - 1 -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
    - 2 4-20 mA output.
    - 3 Maintain accuracy up to 20 to 1 ratio turndown.
    - 4 Reference Accuracy: +0.2% of full span.
  - c. Acceptable Manufacturers: Johnson Controls and Setra.
5. Low Differential Air Pressure Applications (0" to 5" w.c.)
  - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - 1 (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
    - 2 4-20 mA output.
    - 3 Maintain accuracy up to 20 to 1 ratio turndown.
    - 4 Reference Accuracy: +0.2% of full span.
  - c. Acceptable Manufacturers: Johnson Controls and Setra.
6. Medium Differential Air Pressure Applications (5" to 21" w.c.)
  - a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
    - 1 Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
    - 2 Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
    - 3 Thermal Effects:  $<+.033$  F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
  - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter



shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

- c. Acceptable manufacturers: Johnson Controls and Setra.

E. Flow Monitoring

1. Air Flow Monitoring

- a. Provide airflow temperature measurement devices where indicated on the plans. Airflow devices shown on HVAC equipment schedules shall be provided and factory installed by the equipment manufacturer. Airflow devices will be as specified in the central control and monitoring specification.
- b. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. Each transmitter shall operate on 24VAC.
- c. Each sensing point shall independently determine the airflow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output.
- d. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range of 0-5000FPM and be wind tunnel calibrated or verified against standards that are traceable to NIST.

- (a) The number of sensor housings provided for each location shall be

Duct or Plenum Area (sq. ft)	Total # Sensors/Location
<2	4
2 to <4	6
4 to <8	8
8 to <16	12
>=16	16

- e. The transmitter shall be capable of communicating with the host controls using the following interface options:
- (a) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4 wire)
- (b) RS-485: Field selectable Johnson Controls N2 Bus

- f. Acceptable Manufacturers: Ebtron

2. Water Flow Monitoring

- 1 Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
- 2 Acceptable manufacturers: Onicon

F. Power Monitoring Devices

1. Current Measurement (Amps)

- a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

- b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
  - 1 Operating frequency – 50 - 400 Hz.
  - 2 Insulation – 0.6 Kv class 10Kv BIL.
  - 3 UL recognized.
  - 4 Five amp secondary.
  - 5 Select current ration as appropriate for application.
  - 6 Acceptable manufacturers: Veris Industries
- c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
  - 1 6X input over amp rating for AC inrushes of up to 120 amps.
  - 2 Manufactured to UL 1244.
  - 3 Accuracy: +.5%, Ripple +1%.
  - 4 Minimum load resistance 30kOhm.
  - 5 Input 0-20 Amps.
  - 6 Output 4-20 mA.
  - 7 Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
  - 8 Acceptable manufacturers: Veris Industries
- G. Smoke Detectors
  - 1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.
- H. Status and Safety Switches
  - 1. General Requirements
    - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the CCMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
  - 2. Current Sensing Switches
    - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
    - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
    - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
    - d. Acceptable manufacturers: Veris Industries
  - 3. Air Filter Status Switches
    - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

- b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
  - c. Provide appropriate scale range and differential adjustment for intended service.
  - d. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 4. Air Flow Switches
  - a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
  - b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 5. Air Pressure Safety Switches
  - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
  - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
  - c. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 6. Water Flow Switches
  - a. Water flow switches shall be equal to the Johnson Controls P74.
- 7. Low Temperature Limit Switches
  - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
  - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
  - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
  - d. The low temperature limit switch shall be equal to Johnson Controls A70.

## 2.7 Output Devices

### A. Actuators

- 1. General Requirements
  - a. Damper and valve actuators shall be electronic. Controls submittals shall indicate actuator fail position as normally open or closed.
- 2. Electronic Damper Actuators
  - a. Electronic damper actuators shall be direct shaft mount.
  - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of

- operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
- c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
  - d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
  - e. Acceptable manufacturers: Johnson Controls, Mamac.
3. Electronic Valve Actuators
- a. Electronic valve actuators shall be manufactured by the valve manufacturer.
  - b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
  - c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer’s recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
  - d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
  - e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
  - f. Acceptable manufacturers: Johnson Controls

B. Control Relays

1. Control Pilot Relays

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

C. Control Valves (Chilled Water)

1. All modulating control valves shall be of the “pressure independent” type configured with one integrated valve body that incorporates one chamber with an adjustable Cv and a separate pressure regulating chamber used to maintain a constant differential pressure across the control surface.
2. Each control valve shall be individually flow tested at the factory and verified to deviate no more than  $\pm 5\%$  through the selected operating pressure range. A calibrated performance tag shall be provided with each valve that verifies the flow rate in 10° rotation increments up to full rated flow (option with 1/2”). All testing shall be performed with instruments calibrated to the requirements of ANSI/ISA-S75.11-1985, with traceability to NIST and/or ISO standards.
3. Control valve rangeability shall be 100:1 minimum.
4. Each control valve shall be subjected to 70 psid and tested to exceed ANSI/FCI 70-2-1998 leakage ratings. Class IV leakage or better is required for control valves 2" nominal size and less. Class III leakage or better is required for control valves larger than 2".
5. In all control valves 8" and smaller, it shall be possible to modify the valve flow characteristics without removing the valve from the piping system.
6. Balancing valves and associated balancing shall not be required where pressure independent modulating control valves are installed.
7. The control valve actuator shall modulate all valves up to 8" in nominal size from 0 to 100% design flow while rotating the valve stem a maximum of 90°.
8. There shall be three ports installed at the factory integral to each valve and capable of being used to measure pressure or temperature. The first port shall be installed at the inlet to the valve. The second shall be installed between the Cv chamber and the pressure regulating chamber. The third shall be installed at the outlet of the valve. Should the ports not be provided as part of the valve body than they shall be installed in a spool piece and attached to the body.
9. The differential pressure between the first and the third port shall be used in commissioning to verify that the minimum differential pressure (typically 5 psid) required for pressure independent operation is available.
10. The differential pressure between the first and second ports shall be used to verify proper valve operation and flow regulation. It shall be possible to verify the flow rate through the control valve using the valve stem position and the differential

pressure measurement between the first and second port in the valve. If these valve features are not available, a flow meter shall be installed to verify actual flow rate in operation through the valve.

11. CB valves to be standard modulating.
12. All valves shall be warranted by the manufacturer for no less than 5 years from the date of purchase.
13. Acceptable manufacturers: Johnson Controls, Danfoss, Delta Flow

D. Control Valves (Hot Water & Steam Systems)

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
3. Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
4. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.
6. Acceptable manufacturers: Johnson Controls, Danfoss, Delta Flow

## 2.8 Miscellaneous Devices

### A. Local Control Panels

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

### B. Thermostats

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

## 3. PART 3 – PERFORMANCE / EXECUTION

### 3.1 CCMS Specific Requirements

#### A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

#### B. Actuation / Control Type

1. Primary Equipment
  - a. Controls shall be provided by equipment manufacturer as specified herein.
  - b. All damper and valve actuation shall be electric.

2. Air Handling Equipment
  - a. All air handlers shall be controlled with a HVAC-DDC Controller
  - b. All damper and valve actuation shall be electric.
3. Terminal Equipment:
  - a. Terminal Units (VAV, FPVAV, FCU etc.) shall have electric damper and valve actuation.
  - b. All Terminal Units shall be controlled with HVAC-DDC Controller)

### 3.2 Installation Practices

#### A. CCMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Central Control and Monitoring System, as herein specified, shall be provided by the CCMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.
2. All CCMS wiring materials and installation methods shall comply with CCMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the CCMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the CCMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
  - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
  - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

#### B. CCMS Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.



4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

C. Penetrations

1. Provide fire stopping for all penetrations used by dedicated CCMS conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

D. CCMS Identification Standards

1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.  
Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

E. CCMS Panel Installation

1. The CCMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
2. The CCMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

F. Input Devices

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the CCMS in accessible local control panels wherever possible.

G. HVAC Input Devices – General

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the CCMS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
  - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
  - b. Sensors shall be installed with a rain proof, perforated cover.
6. Water Differential Pressure Sensors

- a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
  - b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
  - c. The transmitters shall be installed in an accessible location wherever possible.
7. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
  - a. Air bleed units, bypass valves and compression fittings shall be provided.
8. Building Differential Air Pressure Applications (-1" to +1" w.c.):
  - a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
  - b. The interior tip shall be inconspicuous and located as shown on the drawings.
9. Duct Temperature Sensors:
  - a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
  - b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
  - c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
  - d. The sensor shall be mounted to suitable supports using factory approved element holders.
10. Space Sensors:
  - a. Shall be mounted per ADA requirements.
  - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
11. Low Temperature Limit Switches:
  - a. Install on the discharge side of the first water or steam coil in the air stream.
  - b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
  - c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
12. Air Differential Pressure Status Switches:
  - a. Install with static pressure tips, tubing, fittings, and air filter.
13. Water Differential Pressure Status Switches:
  - a. Install with shut off valves for isolation.
- H. HVAC Output Devices
  1. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
  2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Central Control and Monitoring System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

### 3.3 Training

- A. The CCMS contractor shall provide the following training services:
  1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the CCMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

### 3.4 Commissioning

- A. Fully commission all aspects of the Central Control and Monitoring System work.
- B. Acceptance Check Sheet
  1. Prepare a check sheet that includes all points for all functions of the CCMS as indicated on the point list included in this specification.
  2. Submit the check sheet to the Engineer for approval
  3. The Engineer will use the check sheet as the basis for acceptance with the CCMS Contractor.
- C. VAV box performance verification and documentation:
  1. The CCMS Contractor shall test each VAV box for operation and correct flow. At each step, after a settling time, box air flows and damper positions will be sampled. Following the tests, a pass/fail report indicating results shall be produced and submitted to the engineer for review. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.
  2. The CCMS Contractor shall issue a report based on a sampling of the VAV calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data.
- D. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

### 3.5 SEQUENCE OF OPERATION

#### 1. GENERAL

- a. Power - Fail Restart:
  - 1 In the event of a power failure the FMS computer will analyze the status of all controlled equipment and compare it with normal occupancy scheduling. The equipment will then be started or stopped as necessary to prevent all equipment from coming on at the same time.
- b. FMS Monitoring:
  - 1 Refer to the attached Input/Output schedule for a listing of all monitoring and override points and for additional software features.
- c. Optimal Start:
  - 1 All scheduled HVAC equipment will be started based on an optimal start feature that will calculate the approximate time the unit will have to be started prior to scheduled start time in order for the space temperature to be at set point at scheduled occupancy.
  - 2 Once space temperatures reach occupied set point O.A. dampers will be modulated open. Whenever the unit goes in the unoccupied mode the O.A. damper will be closed.
- d. Night High Limit and Night Low Limit:
  - 1 During unoccupied periods scheduled HVAC equipment will be energized whenever space temperature drops below a night low limit set point of 65 degrees(adjustable) or a night high limit of 85 degrees(adj).
- e. Smoke dampers and smoke detectors:
  - 1 Units 15,000 CFM or greater will be provided with both supply and return air smoke detectors (provided and wired by div 26 – installed by div 23) as well as both supply and return air smoke dampers. When the unit is to be started the supply and return air smoke dampers will be driven open. The supply fan will be started once the AHU supply and return air dampers reach 100% open as indicated by damper end switches. When the unit is stopped the smoke dampers will not be allowed to close until the supply fan has been allowed to coast down to a complete stop.

#### 2. DOAS-1

- a. General:
  - 1 Outside Air Units shall supply neutral temperature air to the building.
  - 2 Provide supply air discharge sensor for monitoring only.
- b. Start/Stop:
  - 1 The unit will be started and stopped based on a time of day schedule from the FMS.
  - 2 Once the start sequence is initiated, the outside and exhaust air dampers shall open. Once the outside air and exhaust air dampers are proven open, the supply and exhaust fan shall be commanded to run
- c. Recirculation Mode:
  - 1 Recirculation of return air shall only be initiated via a user bypass in the controls interface. Bypass damper shall be opened, fresh air damper shall be closed, and wheel operation shall stop.

- d. Safeties:
    - 1 Duct smoke detector will shut the supply fan off whenever products of combustion are sensed. The smoke detector will be provided and wired back to fire alarm system by division 26 and interlocked with the fan starter under division 23.
    - 2 When commanded by the fire alarm system to shut down, the supply fan shall be shut down and the exhaust fan shall continue to operate via separate generator backed power supply.
    - 3 A temperature low limit switch will shutdown the fan whenever mixed air temperatures drop below 38 degrees.
    - 4 A static pressure high limit switch will shut down the air handler whenever static pressure in the discharge of the air handler exceeds 5" W.G.
  - e. Temperature/Humidity Control Summer:
    - 1 During summer mode (ambient dew-point is above summer supply air dew-point set point), mechanical cooling and dehumidification is enabled and chilled water valve is modulated to maintain supply air dew-point set point. Heat is utilized for reheating supply air to neutral conditions at reheat coil when outdoor temperatures drop below dew point setpoint.
  - f. Temperature/Humidity Control Winter:
    - 1 During winter mode, supply air is preheated through energy recovery, and heated at pre-heat coil as required to maintain winter supply air temperature set point.
  - g. Filter:
    - 1 Provide Analog differential pressure sensor for filter monitoring.
3. AHU-1 [Variable Air Volume Unit]
- a. Start/Stop:
    - 1 The unit will be capable of being started and stopped based on a time of day schedule from the FMS.
    - 2 When the unit goes into the occupied mode and is to be started, the outdoor air damper will be driven to its minimum CFM position, as sensed by outdoor air CFM measuring device. The outdoor air damper will remain closed during night low limit and morning warmup. Outdoor air damper will be modulated to maintain minimum ventilation CFM as shown on mechanical schedule.
  - b. Safeties:
    - 1 Duct smoke detector will shut the supply fan off whenever products of combustion are sensed. The smoke detector will be provided and wired back to fire alarm system by division 26 and interlocked with the fan starter under division 23.
    - 2 A temperature low limit switch will shutdown the fan whenever mixed air temperatures drop below 38 degrees .
    - 3 A static pressure high limit switch will shut down the air handler whenever static pressure in the discharge of the air handler exceeds 5" W.G.

c. Temperature Control:

- 1 Discharge air temperature shall be controlled at 55 degrees F. (adjustable) by modulating the CHW valve as necessary to maintain set point.
- 2 When outside air temperature is below 55 degrees, the outside air damper shall be modulated open to control discharge air temperature. The building pressure sensor shall limit the damper position to maintain no greater than 0.1" building positive pressure.
- 3 Discharge Temperature Reset Schedule: Discharge air reset schedule shall be adjustable

Outside Air Temp	Discharge Air Temp
55°F	55°F
45°F	65°F

d. Preheat Coil Discharge Air Control:

- 1 Preheat coil discharge air temperature shall be controlled at 55 degrees (adjustable) by modulating preheat control valve as required to maintain set point.

e. Pressure Control:

- 1 The supply variable speed drive shall be modulated to maintain supply duct static pressure set point of 1 in w.g.
- 2 When the supply fan starts the VSD shall be in the "unloaded" position. VSD will load fan over an adjustable time period.

f. Filter:

- 1 Provide Analog differential pressure sensor for filter monitoring.

4. VAV BOXES

- a. Each VAV box shall be controlled by a unit mounted DDC controller. On a call for cooling the air valve will be modulated as required to maintain room temperature set point. As space temperature drops below set point the air valve will be modulated to minimum heating position. On a continued drop in space temperature, the hot water reheat valve will be modulated open.

5. SPLIT SYSTEM HEAT PUMPS:

a. Start/Stop:

- 1 Units will be will be started and stopped by the CCMS
- 2 When the unit goes into the occupied mode and is to be started, the outdoor air damper will be driven open. The outdoor air damper will remain closed during night low limit and morning warm up.

b. Temperature Control:

- 1 Units will be controlled by a unit mounted DDC controller. On a call for cooling the compressor will be cycled as required to maintain room temperature set point. As space temperature drops below set point the heating cycle will be enabled and the compressor will be cycled as required to maintain room temperature set point. On a continued drop in space temperature, the electric auxiliary heater will be cycled to maintain room temperature set point. Wiring of condensing units and space sensors to be provided under this section.

6. FCU'S [Fan Coil Units]

a. General:

- 1 Fan coil units will be controlled by a standalone DDC controller with wall mounted room temperature sensor/command module.
- 2 Command module shall be provided with fan speed override button that will provide local unit start/stop and fan speed adjustment from low speed, to medium speed to high speed. Command module shall also be provided with set point adjustment and digital display for local readout of room temperature, room temperature set point and fan command status (i.e. on/off, low speed/medium speed/high speed).
- 3 Provide supply air discharge temperature sensor for monitoring only.

b. Start Stop:

- 1 Each FCU will run continuously but will have the ability to be started and stopped by the FMS system or the local fan speed switch.
- 2 Each FCU located in a Study Room, Living Room or Community Room shall be started and stopped based on a time of day schedule.

c. Safeties:

- 1 Each FCU will be provided with a drain pan float switch. Float switch will be wired to alarm at the CCMS and to shut off fan and close valves when ever excess water is detected in drain pan.

d. Temperature Control:

- 1 Room temperature, as sensed by wall mounted room temperature sensor, will be controlled by modulating the fan coil unit CHW and HW control valves and modulating the fan speed (Low-Medium-High) as required to maintain return air temperature set point.

7. CHILLED WATER SYSTEM:

a. Chilled Water Pump Start-Stop Control:

- 1 Building Chilled Water pumps will operate in a primary and standby configuration. Primary CHW pump will be started whenever differential pressure at most remote fan coil unit drops below set point of 5 PSI. Pump will be stopped if the pump continuously operates at minimum speed for 60 minutes. In the event of a failure of a primary pump an alarm will be given at the FMS computer and the standby pump will automatically be started. Primary and standby pumps will be automatically alternated on a weekly basis.

b. Chilled Water Pump Speed Control:

- 1 Whenever the DDC controller detects that a pump is on, it will sense the differential pressure in the chilled water system and modulate the variable speed drive of that pump as required to maintain the differential pressure set point.

8. HOT WATER SYSTEM:

a. Hot Water Pump Start Stop Control:

- 1 Hot Water pumps will operate in a primary and standby configuration. In the event of a failure of a primary pump an alarm will be given at the FMS computer and the standby pump will be automatically started. Primary and standby pumps will be automatically alternated on a weekly basis.

b. Hot Water Pump Speed Control:

- 1 Whenever the DDC controller detects that a pump is on, it will sense the differential pressure in the hot water system and modulate the variable speed drive of that pump as required to maintain the differential pressure set point.
- 2 The HW system DDC controller will sense the hot water supply temperature and outside air temperature in order to determine the hot water supply temperature set point. The set point will be reset according to the following adjustable reset schedule.

Outside Air Temperature	Hot Water Supply Temperature
20°F	160°F
65°F	120°F

- 3 The DDC controller will modulate the HEX steam control valves as required to maintain the calculated hot water supply temperature set point.

9. EXHAUST FANS:

- a. Exhaust fans will be interlocked and controlled as indicated on fan schedule.

B. ENERGY MONITORING

1. Building CHW BTU Meter:

- a. An Onicon Sysem-10-N2/BACnet Model F-3500 CHW BTU meter will be provided for monitoring of total building CHW consumption:

2. Building Steam BTU Meter:

- a. Veris-Acclelabar Model AFS with Foxboro IMV30 Multivariable Transmitter with remote mount, instantaneous steam flow rate (lbs/hr) and energy total (BTU x 100), and connectivity to Johnson Control Metasys.

3. Domestic Hot Water:

- a. An Onicon Hot Water BTU meter will be provided for monitoring of total building domestic hot water consumption (refer to plumbing drawings for location and size):

4. Domestic Water:

- a. An Onicon flow meter will be provided for monitoring of total building domestic water consumption.

5. Data Rooms and Elevator Equipment Rooms:

- a. Provide space sensors for temperature monitoring of Data Rooms and Elevator Equipment Rooms as indicated on drawings. Provide an alarm if space temperature exceeds 80 degrees (adj.).

6. Electrical Consumption:

- a. Electrical power meters as shown on electrical drawings and designated as “Digital Meter” will be provided under this section for KW monitoring . Power meters will be BACnet compatible and will be connected to the CCMS under this contract.



7. Fire Smoke Dampers:

- a. Fire smoke dampers shall be controlled and wired by the Controls Contractor per details on mechanical plans.

3.6 SMOKE CONTROL FANS CONTROL:

- A. All fans, dampers, and other HVAC equipment that are part of a smoke control system shall be monitored and controlled by a U.L Listed Fire Fighters' Smoke Control Panel (FSCP) in accordance with NFPA 92. The FSCP Shall be manufactured by Alerton. The FSCS size and capacity shall be as required by the number of smoke control points. The station shall be located in the fire command center. The FSCP shall comply with building code requirements and NFPA 92 guidelines.
- B. Stair pressurization fan shall be provided with a duct smoke detector in the airstream to de-energize the fan upon detection of smoke. A red indicator, with reset switch, labeled "smoke detector trip" shall be located on the face of the firefighter's smoke control panel adjacent to the Fan's manual override switch. The duct detector shall be furnished by the electrical contractor, mounted by the mechanical contractor and power wired by the electrical contractor.
- C. Stair pressurization fan shall be provided with a motorized damper on the discharge side of the fan. Damper shall be fully open prior to emerging fan.
- D. Smoke control fans shall be controlled by differential pressure sensors every 3 floors near the supply air grille shown on the riser diagrams. Differential pressure shall be controlled at a minimum of 0.10" and shall not exceed 0.35" at any sensor.

End of Section 23 09 00

## SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL - GMP-2

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Provide all labor, materials, equipment and supervision to construct complete and operable electrical systems as indicated on the drawings and specified herein.
- B. All materials and equipment used shall be new, undamaged and free from any defects.

#### 1.2 RELATED DOCUMENTS AND OTHER INFORMATION

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section, individually and collectively.

#### 1.3 PRODUCT WARRANTIES

- A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceeds the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year from the date of substantial completion.
  - 1. Where manufacturer's warranty lists a start date of PO or date of ship, contractor shall purchase extended warranty to ensure warranty period extends to a minimum of 1 year after date of substantial completion.

#### 1.4 PRODUCT SUBSTITUTIONS

- A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of the Architect at least 10 days prior to opening of bids.

#### 1.5 SUBMITTAL REQUIREMENTS

- A. Submit for review by the Engineer Architect a schedule with engineering data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive materials, i.e., catalog sheets, product data sheets, diagrams, performance curves and charts published by the manufacturer, warranties, etc., to show conformance to Specifications and Plan requirements; model numbers alone shall not be acceptable. Data submitted for review shall contain all information to indicate compliance with Contract Documents. Complete electrical characteristics shall be provided for all equipment. Submittals for lighting fixtures shall include Photometric Data. The Engineer reserves the right to require samples of any equipment to be submitted for review.
- B. The purpose of shop drawing review is to demonstrate to the Architect that the Contractor understands the design concept. The Architect's review of such drawings, schedules, or cuts

shall not relieve the Contractor from responsibility for deviations from the drawings or specifications unless he has, in writing, called the Architect's attention to such deviation at the time of submission, and received written permission from the Architect for such deviations.

- C. Where cut sheets include an entire product family, mark all specific items to be utilized for this project on equipment cut sheets. Generic cut sheets with no indication of which items on the cut sheet shall be used will be rejected.
- D. Response to Submittals: Shop drawings shall be noted with the following classifications:
  - 1. "Reviewed": No corrections, no marks. Contractor shall submit copies for distribution.
  - 2. "Provide as Corrected": A few minor corrections. Items may be ordered as marked up without further resubmission. Submit shall submit copies for distribution. Formally correct prior to submitting O&M manuals.
  - 3. "Revise and Resubmit": Minor corrections. Items may be ordered at the Contractor's option. Contractor shall resubmit documents with corrections noted.
  - 4. "Rejected": Major corrections required or not in accordance with the contract documents. Contractor shall correct and resubmit documents.

## 1.6 ELECTRICAL DRAWINGS

- A. Electrical contract drawings are diagrammatic and indicate the general arrangement of electrical equipment. Do not scale electrical plans. Obtain all dimensions from the Architect's dimensioned drawings and field measurements. The Contractor shall review Architectural plans for door swings and built-in equipment; conditions indicated on those plans shall govern for this work.
- B. Coordinate installation of electrical equipment with the structural and mechanical equipment and access thereto. Coordinate exterior electrical work with civil and landscaping work.
- C. Discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions shall be installed to provide the better quality or greater quantity of work; or, comply with the more stringent requirement; either or both in accordance with the A/E's interpretation.

## 1.7 SUBMITTALS – GENERAL ELECTRICAL

- A. Electrical coordination drawings shall be provided as described below:
  - 1. Electrical Rooms: Provide layouts of all electrical rooms using the dimensions of equipment and accessories actually furnished. Locate all ducts and piping entering or crossing these spaces.
  - 2. Feeders over 100 Amps: The routing of main feeders is not shown on the drawings. Actual routing shall be determined by the contractor in accordance with the specifications and shall be coordinated with work by other trades. For underground lines, show all utility crossings.
  - 3. Drawings Format: Drawings shall be prepared at a scale of no less than 1/16"=1'-0" for feeder routes and 1/4"=1'-0" for electrical rooms / equipment yards. Drawing shall be titled to define Project Name, Drawing subject and date prepared. Drawings are to be prepared in AutoCAD or compatible software.

- B. Firestopping Submittals shall be provided for each proposed system type prior to installation. Submittal shall include the following:
  - 1. Firestopping Materials
  - 2. Firestopping Installation Drawings for each conduit penetration, cable in metal sleeve penetration, and blank metal sleeve penetration for each type of wall / floor construction encountered.
  - 3. Provide fire rated “putty-pads” on all electrical boxes in fire rated partitions.

#### 1.8 SYSTEMS REQUIRING ROUGH-IN

- A. Rough-in shall consist of all outlet boxes/raceway systems/supports and sleeves required for the installation of cables/devices by other Divisions and by the Owner. It shall be the responsibility of this Contractor to determine the requirements by reviewing the contract documents and meeting with the Superintendent of the trade involved and Owner’s representative to review submittal data, shop drawings, etc.
- B. Sealing of all sleeves, to meet the fire rating of the assembly, whether active or not, is work of this Division.

#### 1.9 EXISTING SERVICES AND FACILITIES

- A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.
- B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.
- C. Removed Materials: Existing materials made unnecessary by the new installation shall be stored on site. They shall remain the property of the Owner and shall be stored at a location and in a manner as directed by the Owner. If classified by the Owner's authorized representative as unsuitable for further use, the material shall become the property of the Contractor and shall be removed from the site at no additional cost to the owner.
- D. Contractor shall review drawings for all trades for coordination with existing conditions. Contractor shall be responsible for routing of underground raceways and coordinate with GC and other trades for cutting and repair of existing slabs, parking areas, sidewalks, sheetrock and/or plaster walls, etc.
- E. Contractor shall be responsible for coordinating with contract documents and other trades for routing of ducts, pipes, cable-tray and other components with existing conditions. Contractor shall be responsible for field verifying source of raceways and cabling that are in conflict regardless of whether they serve devices in the area of work or not. The relocation of these raceways to assist in avoiding these conflicts shall also be included at no additional cost to the owner.

- F. Contractor shall protect all existing low-voltage cabling from damage. If conflicts arise, contact architect immediately to determine status of cabling. Existing cabling that is damaged during construction shall be replaced by the contractor.

## PART 2 - PRODUCTS

### 2.1 FIRESTOPPING:

- A. A firestop system shall be used to seal penetrations of electrical conduits and cables through fire-rated partitions per NEC 300.21, and NEC 800.26. The firestop system shall be qualified by formal performance testing in accordance with ASTM E-814, or UL 1479.
- B. The firestop system shall consist of a fire-rated caulk type substance and a high temperature fiber insulation. It shall be permanently flexible, waterproof, non-toxic, smoke and gas tight and have a high adhesion to all solids so damming is not required. Only metal conduit shall be used in conjunction with this system to penetrate fire rated partitions. Install in strict compliance with manufacturer's recommendations. 3M or approved equal.
- C. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- D. Comply with BICSI TDMM, "Firestopping Systems" Article.

## PART 3 - EXECUTION

### 3.1 PRODUCT INSTALLATION, GENERAL

- A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product conditions and unforeseen problems.
- B. Protection and Identification: Deliver products to project properly identified with names, models numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.
- C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.
- D. Install temporary protective covers over equipment enclosures, outlet boxes and similar items after interiors, conductors, devices, etc. are installed, to prevent the entry of construction debris and to protect the installation during finish work performed by others. Do not install device plates, equipment covers or trims until finish work is complete.
- E. Clean all equipment, inside and out, upon completion of the work. Scratched or marred surfaces shall be touched-up with touch-up paint furnished by the equipment manufacturer.

- F. Replace all equipment and materials that become damaged.
- G. No more than three phase conductors, each of opposite phases for a three phase WYE system, shall be combined in a single raceway unless written approval is granted by the engineer or noted otherwise on the construction documents. 120 volt receptacle and lighting circuits are except from this requirement, but must meet the requirements of the NEC.
- H. Shared neutrals shall not be utilized (including, but not limited to homeruns) unless written permission is obtained from the Engineer for a specific application.

### 3.2 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
- B. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
- C. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
- D. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
- E. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
- F. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

### 3.3 UTILITY CONNECTIONS:

- A. Coordinate the connection of the electrical system with the owner's utility group. Comply with the requirements of owner's utility group.

### 3.4 ELECTRICAL WORK:

- A. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
  - 1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA

70E.

2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the Contractor. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Owner/ Architect.

END OF SECTION 26 05 00

## SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Medium voltage cable.
  - 2. Cable terminations.
  - 3. Fireproofing tape.
  - 4. Underground cable markers.
  - 5. Bedding and cover materials.

#### 1.2 REFERENCES

- A. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

#### 1.3 SUBMITTALS

- A. Product Data: Submit for cable, terminations, and accessories.
- B. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual sizes and locations of cables.
- B. Operation and Maintenance Data: Submit instructions for testing and cleaning cable and accessories.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect cable ends from entrance of moisture.



## PART 2 PRODUCTS

### 2.1 MEDIUM VOLTAGE CABLE

- A. Manufacturers:
  - 1. The Okonite Company
  - 2. Prysmian
  - 3. Southwire
  - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Voltage: 15 kV.
- C. Insulation Level: EPR/Copper Tape Shield/ PVC, 133 percent of operating voltage.
- D. Cable Continuous Operating Temperature Rating: MV-105, 220 mils.
- E. Configuration: Single conductor.
- F. Conductor Material: Copper.

### 2.2 CABLE TERMINATIONS

- A. 600A 15/25 Class Deadbreak Elbows on 2-point Junction
- B. Location: Outdoor Vaults or Enclosures.
- C. Type: Cold shrink.

### 2.3 FIREPROOFING TAPE

- A. Product Description: Flexible, conformable fabric, coated on one side with flame retardant, flexible polymeric or chlorinated elastomer. Non-corrosive to and compatible with cable sheaths jackets. Does not support combustion.
- B. Width: Approximately 3 inches (76 mm).
- C. Thickness: Not less than 0.03 inch (0.76 mm).
- D. Weight: Not less than 2.5 pounds per square yard (1.4 kilogram per square meter).

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.
- B. Verify existing ducts and manholes are ready to receive cable.
- C. Verify routing and termination locations of cable prior to rough-in.

### 3.2 PREPARATION

- A. Use swab to clean ducts before pulling cables.

### 3.3 EXISTING WORK

- A. Remove abandoned medium-voltage cable.
- B. Maintain access to existing medium-voltage cable and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Extend existing medium-voltage cable installations using materials and methods compatible with existing electrical installations, or as specified.

### 3.4 INSTALLATION

- A. Avoid abrasion and other damage to cables during installation.
- B. Use suitable manufacturer approved lubricants and pulling equipment.
- C. Sustain cable pulling tensions and bending radii below manufacturer's recommended limits.
- D. Ground cable shield at each termination and splice.
- E. All splices made shall be rated suitable for water immersion.
  - 1. Connect with UL listed copper bodied connectors tested and approved for use at medium or high voltage.
    - a. Mechanical type connectors such as split-bolt or polaris type kits are not allowed.
  - 2. Use molded rubber kit with peroxide cure (3M splice kits or owner-approved equal) for reinsulating. Contractor shall use cold shrink terminations (3M or owner-approval equal) with 2-hole lugs.
  - 3. Provide flexible woven mesh of tin-plated copper braid for reshielding. Provide a separate jumper braid to connect the cable's metallic shields.
- F. Install cables in manholes along wall providing longest route. Provide a minimum of  $\frac{3}{4}$  loop from entry to termination point required in each manhole.
- G. Arrange cable in manholes to avoid interference with duct entrances.
- H. Install equipment grounding conductors encased in conduit duct bank and around inside wall of manhole in accordance with Article 250 of NFPA 70.

### 3.5 FIREPROOFING

- A. Apply fireproofing tape to cables when installed in manholes, cable rooms, pull boxes, or other enclosures.

- B. Smooth out irregularities, at splices or other locations, with insulation putty before applying fireproofing tape.
- C. Apply fireproofing tape tightly around cables spirally in half-lapped wrapping or in butt jointed wrapping with second wrapping covering joints first.
- D. Extend fireproofing 1 inch (25 mm) into conduit or duct.
- E. Install tape with coated side toward cable.
- F. Install random wrappings of plastic tape around fireproofing tape to prevent unraveling.
- G. Install fireproofing to withstand a 200 Ampere arc for 30 seconds.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect exposed cable sections for physical damage.
- B. Provide cable terminations at equipment as directed by Owner. Coordinate work and timing with owner.
- C. Inspect shield grounding, cable supports, and terminations for proper installation.
- D. Inspect and test in accordance with NETA ATS, except Section 4.
- E. Perform inspections and tests listed in NETA ATS, Section 7.3.

### 3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Protect installed cables from entrance of moisture.

END OF SECTION 260513

## SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Rod electrodes.
  - 2. Wire.
  - 3. Grounding well components.
  - 4. Mechanical connectors.
  - 5. Exothermic connections.

#### 1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
  - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
  - 2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
- B. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 25 ohms maximum.

#### 1.4 SUBMITTALS

- A. Product Data: Submit data on grounding electrodes and connections.
- B. Test Reports: Indicate overall resistance to ground.
- C. Manufacturer's Installation Instructions: Submit for active electrodes.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components and grounding electrodes.

## 1.6 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

## 1.7 QUALIFICATIONS

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

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

## 1.9 COORDINATION

- A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

# PART 2 PRODUCTS

## 2.1 ROD ELECTRODES

- A. Product Description:
  - 1. Material: Copper-clad steel.
  - 2. Diameter: 3/4 inch (19 mm).
  - 3. Length: 10 feet (3.0 m).
- B. Connector: Connector for exothermic welded connection.

## 2.2 WIRE

- A. Material: Stranded copper.
- B. Foundation Electrodes: 4 AWG.
- C. Grounding Electrode Conductor: Copper conductor bare.
- D. Bonding Conductor: Copper conductor insulated.

## 2.3 GROUNDING WELL COMPONENTS

- A. Well Pipe: 10 inches inner diameter by 12 inches (600 mm) long Schedule 80 PVC pipe with belled end.
- B. Well Cover: Cast iron with legend "GROUND" embossed on cover.

## 2.4 MECHANICAL CONNECTORS

- A. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.
  - 1. Bonding Jumpers: Compression type connectors, using zinc-plated fasteners and external tooth lock washers.
  - 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
  - 3. Rack and cabinet ground bars: One-hole compression type lugs using zinc-plated or copper alloy fasteners.

## 2.5 EXOTHERMIC CONNECTIONS

- A. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

# PART 3 EXECUTION

## 3.1 EXAMINATION

- A. Verify final backfill and compaction has been completed before driving rod electrodes.

## 3.2 PREPARATION

- A. Remove paint, rust, mill oils, and other surface contaminants at connection points.

## 3.3 EXISTING WORK

- A. Modify existing grounding system to maintain continuity to accommodate renovations.
- B. Extend existing grounding system using materials and methods compatible with existing electrical installations, or as specified.

## 3.4 INSTALLATION

- A. Install in accordance with IEEE 142 and IEEE 1100.
- B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.
- C. Install grounding and bonding conductors concealed from view.

- D. Install grounding well pipe with cover at each rod location nearest to service entrance equipment. Install well pipe top flush with finished grade.
- E. Install grounding electrode conductor and connect to reinforcing steel in foundation footing. Electrically bond steel together. If it is determined that the reinforcing steel cannot be made electrically continuous, install a 4 AWG bare copper conductor in foundation footing around the perimeter of the building.
- F. Bond together metal siding not attached to grounded structure; bond to ground.
- G. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- H. Bond to lightning protection system. Refer to Section 26 41 00.
- I. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- J. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- K. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
- L. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.
- M. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.
- N. Permanently attach equipment and grounding conductors prior to energizing equipment.

### 3.5 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.
- C. Perform ground resistance testing in accordance with IEEE 142.

- D. Perform continuity testing in accordance with IEEE 142.
- E. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION 26 05 26



## SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Conduit and equipment supports.
  - 2. Anchors and fasteners.

### PART 2 PRODUCTS

#### 2.1 CONDUIT SUPPORTS

- A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- D. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- E. Cable Ties: High strength nylon temperature rated to 185 degrees F (85 degrees C). Self locking.

#### 2.2 FORMED STEEL CHANNEL

- A. Product Description: Galvanized 12 gage (2.8 mm) thick steel. With holes 1-1/2 inches (38 mm) on center.

#### 2.3 SPRING STEEL CLIPS

- A. Product Description: Mounting hole and screw closure.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. The use of powder-actuated anchors is not allowed.
- B. Do not drill or cut structural members.

### 3.2 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
  - 1. Concrete Structural Elements: Provide expansion anchors.
  - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, and steel ramset fasteners.
  - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
  - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
  - 5. Solid Masonry Walls: Provide expansion anchors.
  - 6. Sheet Metal: Provide sheet metal screws.
  - 7. Wood Elements: Provide wood screws.
- B. Install conduit and raceway support and spacing in accordance with NEC.
- C. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- D. Install multiple conduit runs on common hangers.
- E. Support wires above suspended ceilings for electrical system fixtures, devices and cabling shall be clearly identified. See section 260553.
- F. Supports:
  - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
  - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
  - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch (25 mm) off wall.
  - 4. Support vertical conduit at every other floor.

### 3.3 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches (87 mm) thick and extending 6 inches (150 mm) 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.

### 3.4 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 26 05 29

## SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

#### 1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
  - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
  - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
  - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 5. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
  - 6. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

#### 1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground Branch Circuits: Provide nonmetallic conduit (schedule 40 PVC) with galvanized rigid steel long-sweep 90-degree elbows unless specifically noted otherwise. Provide cast metal boxes or nonmetallic handhole.
- C. Underground Feeders & Service Entrance: Provide Galvanized Rigid Conduit (GRC) or Intermediate Grade Metallic Conduit (IMC) coated with bitumastic coating with long-sweep 90-degree elbows.
- D. Outdoor Locations, Above Grade: Provide galvanized rigid steel or rigid aluminum conduit. Provide cast metal outlet, pull, and junction boxes.
- E. Interior Wet and Damp Locations: Provide galvanized rigid steel or aluminum conduit. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

- F. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- G. Exposed Dry Locations: Provide rigid steel or intermediate metal conduit where subject to damage (up to 7'-0" above finished floor), electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- H. All raceways shall be hard-piped as described above. Flexible raceways shall only be used for whips to light fixtures, or for connections to vibrating equipment.

#### 1.4 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch (19 mm) unless otherwise specified.
- B. All empty raceways shall be provided with a pull string.

#### 1.5 SUBMITTALS

- A. Product Data: Submit for the following:
  - 1. Flexible metal conduit.
  - 2. Liquidtight flexible metal conduit.
  - 3. Nonmetallic conduit.
  - 4. Conduit bodies.
  - 5. Surface raceway.
  - 6. Wireway.
  - 7. Handholes.
- B. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents:
  - 1. Record actual routing of conduits larger than 2 inch (DN50).
  - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC conduit from sunlight.

## 1.8 COORDINATION

- A. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

## PART 2 PRODUCTS

### 2.1 METAL CONDUIT

- A. Rigid Steel Conduit: UL 6 and ANSI C80.1 with full weight screwed fittings. Bushings shall be malleable iron; bushings 1-1/4" and larger shall have insulated throat and grounding lug.
- B. Intermediate Metal Conduit (IMC): UL 1242, galvanized with full weight screwed fittings. Bushings shall be the same as specified for galvanized rigid conduit.
- C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

### 2.2 FLEXIBLE METAL CONDUIT

- A. Product Description: UL360, Interlocked steel construction with PVC jacket and compression type fittings.
- B. Fittings: NEMA FB 1.

### 2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Product Description: UL360, Interlocked steel construction with PVC jacket and compression type fittings.
- B. Fittings: NEMA FB 1.

### 2.4 ELECTRICAL METALLIC TUBING (EMT)

- A. Product Description: UL 797 and ANSI C80.3; galvanized tubing.
- B. Fittings and Conduit Bodies: NEMA FB 1; steel compression type. Fittings 1-1/4" and larger shall have nylon insulated throat. Set-screw, indenter, or drive-on fittings are not allowed.
- C. All EMT conduit shall be Anodized with the following color coating:
  - 1. ~~Emergency Power: Yellow~~
  - 2. ~~Legally required standby or Option standby Power: Orange~~
  - 3. ~~HVAC Equipment Power: Green~~
  - 4. ~~HVAC Controls: Blue (To be provided by mechanical controls contractor)~~
  - 5. Normal Power: Silver

6. Fire Alarm System: Red

2.5 NONMETALLIC CONDUIT

- A. Product Description: NEMA TC 2; Schedule 40 PVC.
- B. Fittings and Conduit Bodies: NEMA TC 3.

2.6 SURFACE METAL RACEWAY

- A. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- B. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories and as required to provide a complete system, finish to match raceway.

2.7 WIREWAY

- A. Product Description: General purpose for interior locations, and Raintight type for exterior locations wireway.
- B. Cover: Hinged cover.
- C. Finish: Rust inhibiting primer coating with gray enamel finish.

2.8 OUTLET BOXES

- A. Manufacturers:
  - 1. Steel City
  - 2. Thomas & Betts
  - 3. Appleton
- B. Sheet Metal Outlet Boxes: UL 514 and NEMA OS 1, Ferrous metal, cadmium, or zinc coated.
  - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported
    - a. Lighting: 4" octagonal x 1" deep.
    - b. Switches and Receptacles: 3"x2"x2-3/4" with appropriate plaster ring.
- C. Cast Boxes: NEMA FB 1, Type FD. Furnish gasketed cover by box manufacturer.
- D. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.9 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

- B. Hinged Enclosures: As specified in Section 26 27 16.
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
  - 1. Material: Galvanized cast iron.
  - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Fiberglass Concrete composite Handholes: Die-molded, glass-fiber concrete composite hand holes:
  - 1. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

#### 3.2 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed.
- D. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- E. Clean and repair existing raceway and boxes to remain.

#### 3.3 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.
- E. Do not install raceways or boxes within 1-1/2" of roof decking to prevent damage from roof installation or repair.

### 3.4 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports.
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route raceway in straight lines, parallel and perpendicular to building lines.
- I. Route conduit under slab from point-to-point.
- J. Maintain clearance between raceway and piping for maintenance purposes.
- K. Maintain 12 inch (300 mm) clearance between raceway and surfaces with temperatures exceeding 104 degrees F (40 degrees C).
- L. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- M. Bring conduit to shoulder of fittings; fasten securely.
- N. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- O. Install conduit hubs or sealing locknuts to fasten conduit to cast boxes.
- P. Install no more than equivalent of three 90 degree bends between boxes for power systems. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch (50 mm) size.
- Q. Install no more than equivalent of two 90 degree bends between boxes for communications systems. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch (50 mm) size.



- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- W. Close ends and unused openings in wireways, junction boxes, and pull boxes.

### 3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.
- B. Adjust box location up to 10 feet (3 m) prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches (150 mm) separation. Install with minimum 24 inches (600 mm) separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.

- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.
- P. Install junction boxes or pull boxes at locations that can be accessed through existing ceiling with a standard ladder. Maximum height of junction boxes above accessible ceiling or through an access panel in a non-accessible is 4' above top of ceiling frame.

### 3.6 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 00.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installer.
- C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

### 3.7 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused openings in boxes.

### 3.8 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION 26 05 33

## SECTION 26 05 34 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

#### 1.3 SUBMITTALS

- A. Product Data: Submit catalog data for floor boxes and/or poke-throughs. Catalog Data shall include:
  - 1. Mounting Type (Slab on Grade, Raised Floor, etc.)
  - 2. Service fittings, devices, and associated coverplates.
  - 3. Size and Number of knockouts.
  - 4. Material and Finish Options.
- B. Samples: Submit two of each service fitting illustrating size, material, configuration, and finish.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.

#### 1.6 EXTRA MATERIALS

- A. Furnish two additional units for all specialty devices that are designed specifically to fit where standard devices will not fit.

## 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 manufacturers:
  - 1. Hubbell
  - 2. Legrand
  - 3. FSR
  - 4. Thomas & Betts
- B. All floor box types shall be furnished from a single manufacturer unless specifically noted otherwise in this specification or in drawings.

### 2.2 FLOOR BOXES

- A. Floor boxes with integral devices (recessed below flush cover) flush mounted in floors above grade shall have the following characteristics:
  - 1. Contain integral devices with gap recessed below cover such that plugs are concealed below cover.
  - 2. Size: As required to support number of full size, standard gang compartments noted on plan.
  - 3. Material: Stamped Steel.
  - 4. Adjustability: Fully adjustable.
  - 5. Shape: Rectangular.
  - 6. Activation Covers: Activation covers shall be flanged with the following characteristics:
    - a. Provide heavy-duty covers rated for minimum load of 8,000 lbs.
    - b. Covers shall be flush type.
    - c. The cover's hinge shall allow for the cover to open 180 degrees.
    - d. The covers shall have been evaluated by UL to meet the applicable U.S. safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

### 2.3 POKE-THROUGH FITTINGS

- A. Product Description: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
- B. Fire Rating: 3 hours.
- C. Service Fitting Type: Flush.
- D. Activation Covers: Activation covers shall be flanged with the following characteristics:
  - a. Provide heavy-duty covers rated for minimum load of 8,000 lbs.
  - b. Covers shall be flush type.
  - c. The cover's hinge shall allow for the cover to open 180 degrees.

- d. Where noted for furniture feed applications, provide furniture feed covers with one (1) 1-inch trade size screw plug opening and one (1) combination 1-1/4" and 2-inch trade size screw plug.
  - e. The covers shall have been evaluated by UL to meet the applicable U.S. safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
  - f. Provide heavy-duty covers rated for minimum load of 8,000 lbs where indicated on plan and where subject to forklift traffic.
- E. Configuration: As described on drawings.

### PART 3 EXECUTION

#### 3.1 COORDINATION

- A. Meet with all other trades (GC, Structural Steel, Mechanical, Plumbing, Fire Protection, etc.) to verify conflicts prior to install.

#### 3.2 EXAMINATION

- A. Verify locations of floor boxes with field conditions and architect prior to rough-in.

#### 3.3 INSTALLATION

- A. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust box location up to 10 feet (without additional cost) to accommodate intended purpose.
- B. Floor Box Requirements: Use floor boxes listed for particular installations (example: in slab on grade, raised floor systems, fire rated floors, etc.).
- C. Set floor boxes level.
- D. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Division 07 Specifications.
- E. Coordinate installation of access floor boxes with access floor system provider prior to bid.

#### 3.4 ADJUSTING AND CLEANING

- A. Adjust floor box flush with finish flooring material.
- B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION 26 05 34

## SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Nameplates.
  - 2. Labels.
  - 3. Wire markers.
  - 4. Underground Warning Tape.
  - 5. Lockout Devices.

#### 1.2 DELIVERY, STORAGE, AND HANDLING

- A. Accept identification products on site in original containers. Inspect for damage.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

#### 1.3 ENVIRONMENTAL REQUIREMENTS

- A. Install nameplates and labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

### PART 2 PRODUCTS

#### 2.1 NAMEPLATES

- A. Product Description: Laminated three-layer plastic with engraved letters on contrasting background color. See specification sections for specific equipment for nameplate color schemes. If no color scheme is specified for specific equipment, provide black letters on a white background.
- B. Letter Size:
  - 1. 1/8 inch (3 mm) high letters for identifying individual equipment and loads.
- C. Minimum nameplate thickness: 1/8 inch (3 mm).

#### 2.2 LABELS

- A. Labels: Embossed adhesive tape, with 3/16 inch (5 mm) black letters on clear background.

#### 2.3 WIRE MARKERS

- A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: -50 deg F to +284 deg F (-46 deg C to +140 deg C).

B. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number.
2. Control Circuits: Control wire number as indicated on shop drawings.

## 2.4 SUPPORT WIRES

- A. Support wires above suspended ceilings for electrical system fixtures, devices, and cabling shall be painted red such that they are easily identified from below.

## 2.5 CONDUIT SYSTEMS (CLEMSON REQUIREMENT)

- A. Description: Provide identifying markers on conduits to name the contents of the conduit in full or abbreviated form with black letters on a background as follows:
1. Power feeder and branch circuits – Orange background with voltage named.
  2. Lighting feeders and branch circuits – Yellow background with voltage named.
  3. Telephone and communications circuits – Blue background with system named.

- B. Markers shall be placed at all junctions and terminations of raceways lengthwise along the raceway, or where not suitable, wrapped around the raceway to form a tag.

- C. Markers shall be positioned such that the view of them is not obstructed.

## 2.6 UNDERGROUND WARNING TAPE

- A. Description: 4 inch (100 mm) wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines.

## 2.7 LOCKOUT DEVICES

- A. Lockout Hasps:
1. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches (184 x 75 mm).

## PART 3 EXECUTION

### 3.1 PREPARATION

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

### 3.2 EXISTING WORK

- A. Install identification on unmarked existing equipment.

- B. Replace lost nameplates for existing equipment to remain in main electrical/mechanical room.

### 3.3 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
  - 1. Install nameplate parallel to equipment lines.
  - 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
  - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
  - 4. Secure nameplate to equipment front using screws, or adhesive.
  - 5. Install nameplates for the following:
    - a. Switchboards.
    - b. Panelboards.
    - c. Disconnect Switches.
    - d. Transfer Switches.
    - e. Lighting Control Panels.
- C. Label Installation:
  - 1. Install label parallel to equipment lines.
  - 2. Install label for identification of branch circuit and panelboard supporting each wiring devices.
  - 3. Install labels for permanent adhesion and seal with clear lacquer.
- D. Wire Marker Installation:
  - 1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
- E. Underground Warning Tape Installation:
  - 1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION 26 05 53



## SECTION 26 05 74 - SHORT CIRCUIT, OVERCURRENT PROTECTION, ARC FLASH HAZARD ANALYSIS

### 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 computer-based, fault-current and overcurrent protective device coordination studies that shall be performed by Belka Engineering Associates based on field data provided by installing contractor. Protective device settings shall be set based on results of the protective device coordination study.
- B. Electronic copies of labels shall be provided by the engineer to the contractor. Contractor shall be responsible for printing labels and installing on equipment.

#### 1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
  - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
  - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
  - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
  - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
  - 6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI):
  - 1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
  - 2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
  - 3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
  - 4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents
- C. The National Fire Protection Association (NFPA)
  1. NFPA 70 - National Electrical Code, latest edition
    - a. NFPA 70E – Standard for Electrical Safety in the Workplace

## PART 2 - PRODUCTS

### 2.1 DATA COLLECTION

- A. Contractor shall furnish all field data as required by the power system studies. The Engineer shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future utility supplies, motors, and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.
- D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

## PART 3 - EXECUTION

### 3.1 FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the electrical contractor under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Architect / Engineer in writing of any required major equipment modifications.

### 3.2 ARC FLASH WARNING LABELS

- A. All recommended overcurrent protective device settings shall be made prior to final printing of the arc flash study and labels.

- B. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- C. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:
  - 1. Location designation
  - 2. Nominal voltage
  - 3. Flash protection boundary
  - 4. Hazard risk category
  - 5. Incident energy
  - 6. Working distance
  - 7. Issue date
- D. Labels shall be machine printed, with no field markings
- E. Labels shall be field installed by the electrical contractor under the Startup and Acceptance Testing contract portion.

END OF SECTION 26 05 74



## WARNING

### Arc Flash and Shock Risk

#### Appropriate PPE Required

**19 in** Arc Flash Boundary  
**1.31 cal/cm<sup>2</sup>** Arc Flash at **18 in**  
**PPE** Arc-rated PPE required. See NFPA 70E-2018, TABLE 130.5(G) or call Env. Safety 864-643-6130  
**208 VAC** Shock Risk when cover is removed  
**00** Glove Class  
**42 in** Limited Approach  
**12 in** Restricted Approach

Location: 1259 BRC RM336 WARM RM UNIT  
Protective Device 1259 BRC SPO23-38/40/42  
Max SC Amps 0.88 kA Date: July 01, 2020



## WARNING

### Arc Flash and Shock Risk

#### Appropriate PPE Required

**36 in** Arc Flash Boundary  
**3.58 cal/cm<sup>2</sup>** Arc Flash at **18 in**  
**PPE** Arc-rated PPE required. See NFPA 70E-2018, TABLE 130.5(G) or call Env. Safety 864-643-6130  
**208 VAC** Shock Risk when cover is removed  
**00** Glove Class  
**42 in** Limited Approach  
**12 in** Restricted Approach

Location: 1259 BRC SP023 XF SEC  
Protective Device 1259 BRC SP023 XF-DSw FU  
Max SC Amps 2.15 kA Date: July 01, 2020



## WARNING

### Arc Flash and Shock Risk

#### Appropriate PPE Required

**3 in** Arc Flash Boundary  
**0.06 cal/cm<sup>2</sup>** Arc Flash at **18 in**  
**PPE** No Arc-rated PPE Required  
**480 VAC** Shock Risk when cover is removed  
**00** Glove Class  
**42 in** Limited Approach  
**12 in** Restricted Approach

Location: 1259 BRC SP023 XF DSsw  
Protective Device 1259 BRC SLO13-20/22/24  
Max SC Amps 2.49 kA Date: July 01, 2020



## WARNING

### Arc Flash and Shock Risk

#### Appropriate PPE Required

**9 in** Arc Flash Boundary  
**0.37 cal/cm<sup>2</sup>** Arc Flash at **18 in**  
**PPE** No Arc-rated PPE Required  
**480 VAC** Shock Risk when cover is removed  
**00** Glove Class  
**42 in** Limited Approach  
**12 in** Restricted Approach

Location: 1259 BRC SP023 XF PRI  
Protective Device 1259 BRC SP023 XF-DSw FU  
Max SC Amps 2.43 kA Date: July 01, 2020

## SECTION 26 05 83 - EQUIPMENT WIRING CONNECTIONS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes electrical connections to equipment.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA WD 1 - General Requirements for Wiring Devices.
  - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

#### 1.3 SUBMITTALS

- A. Product Data: Submit wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- B. Signed Letter from Contractor indicating that shop drawings have been reviewed for all equipment requiring electrical connections that are furnished by other divisions prior to ordering equipment.
- C. Manufacturer's installation instructions.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

#### 1.5 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Prior to ordering electrical gear, compare to electrical requirements listed on electrical drawings for each piece of equipment. Notify architect / engineer immediately of any changes.
- C. Coordinate with equipment shop drawings for devices such as drinking fountains, hand dryers, other appliances, etc. such that devices are located concealed behind appliances and/or maintenance panels unless specifically noted otherwise. Where GFCI protection is required, provide remote means for GFCI protection (circuit breaker unless noted otherwise).
- D. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- E. Sequence electrical connections to coordinate with start-up of equipment.

## PART 2 PRODUCTS

### 2.1 EQUIPMENT REQUIRING ELECTRICAL SERVICE

- A. Provide electrical connections for all electrically driven equipment. Final connections are electrical work, unless specifically noted otherwise. Obtain a copy of the shop drawings of equipment. Review shop drawings to verify electrical characteristics and to determine rough-in requirements, final connection requirements, location of disconnect switch, etc. Notify the General Contractor if the information received is ambiguous or incomplete. Keep a copy of these shop drawings at the project site throughout the course of construction.
- B. Equipment to be connected includes, but is not limited to the following:
  - 1. HVAC Equipment
  - 2. Kitchen Equipment
  - 3. Telephone/Computer Systems
  - 4. Fire Alarm System
  - 5. Elevators
  - 6. Site Lighting
  - 7. A/V systems
  - 8. Control Systems
- C. The design of circuits for electrically driven equipment is based on the product of one manufacturer and may not be representative of all acceptable manufacturers. If equipment furnished has differing characteristics, make necessary adjustments to circuit components at no additional cost to the Owner, subject to the approval of the Architect.
- D. Provide disconnects for all equipment and appliances unless specifically noted otherwise on the drawings.
- E. Provide motor starters for all mechanical equipment unless provided by the mechanical contractor.

### 2.2 CORD AND PLUGS

- A. Attachment Plug Construction: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.
- C. Cord Construction: Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify equipment is ready for electrical connection, for wiring, and to be energized.

### 3.2 EXISTING WORK

- A. Remove exposed abandoned equipment wiring connections, including abandoned connections above accessible ceiling finishes.
- B. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not removed.
- C. Extend existing equipment connections using materials and methods as specified.

### 3.3 INSTALLATION

- A. Make electrical connections.
- B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations. Flexible conduit shall be limited to 6' in length unless specifically noted otherwise.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Install receptacle outlet to accommodate connection with attachment plug.
- E. Install cord and cap for field-supplied attachment plug.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

### 3.4 ADJUSTING

- A. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION 26 05 83



## SECTION 260800- COMMISSIONING OF LIGHTING CONTROL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes commissioning process requirements for Lighting Control Systems, assemblies, and equipment.

- B. Related Sections:

Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

#### 1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Lighting Control Systems: Lighting Control Systems, Equipment, Safeties, Interfaces and Interlocks with other systems.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Pre-Functional Test Checklist and equipment start up reports.

#### 1.5 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests and provide reports at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Lighting Control Systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.

- E. Provide measuring instruments and logging devices, calibrated within one year of date of test unless specifications or industry standards require more stringent calibration periods, to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

#### 1.6 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Lighting Control Systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Organize Contractor provided test data, inspection reports, and certificates in Systems Manual.

#### 1.7 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
  - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Lighting Control Systems, assemblies, equipment, and components to be verified and tested.
  - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  - 5. Certificate of readiness certifying that Lighting Control Systems, subsystems, equipment, and associated controls are ready for testing.
  - 6. Test and inspection reports and certificates.
  - 7. Corrective action documents.

#### PART 2 - PRODUCTS (Not Used)

#### PART 3 - EXECUTION

##### 3.1 TESTING PREPARATION

- A. Provide a fully executed Certificate of Readiness signed by Contractor, Subcontractors, and BAS provider certifying that Lighting Control Systems instrumentation and control systems have been completed and calibrated, pre-tested and inspected and that they are operating according to the Contract Documents, and that pretest set points have been recorded. Provide completed Certificate of Readiness to CxA no less than 7 days prior to the scheduled beginning of on-site CxA verification testing.
- B. Certify that testing and adjusting procedures have been completed and that testing and adjusting reports have been submitted, discrepancies corrected, and corrective work approved.
- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.

- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.2 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Lighting Control Systems testing shall include entire Lighting Control Systems installation, from central equipment, lighting control panels, switches, sensors, devices, interfaces and fixtures. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. CxA will witness the test of all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of system controllers and sensors.
- D. The specific Electrical Systems Subcontractor shall prepare detailed testing plans, procedures, and checklists for Lighting Control Systems, subsystems, and equipment.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the Lighting Control Systems system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

**END OF SECTION 260800**

## SECTION 26 09 23 - LIGHTING CONTROL DEVICES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Remote control lighting relays.
  - 2. Lighting contactors.
  - 3. Time Clocks
  - 4. Switches.
  - 5. Switch plates.
  - 6. Occupancy sensors.
  - 7. Photocells.
  - 8. Photocell control unit.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
  - 4. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.
  - 5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
  - 6. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
  - 7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

#### 1.3 SYSTEM DESCRIPTION

- A. Lighting controls shall be based on lighting control scheme as defined on the drawings. Contractor is responsible for providing system, components, wiring, and programming as required to provide all automatic and manual control functions as defined.
- B. Exterior Lighting Controls shall be based on combination Time Clock, Photocells, and contactors or relays as required to support astronomical time based scheduling, measurement of daylight, and a combination of the two.

#### 1.4 SUBMITTALS

- A. Time Line for delivery, installation, and factory start-up. Lighting controls shall be completed, and factory commissioned prior to final walk-through.
- B. Shop Drawings: Indicate dimensioned drawings of lighting control system components and accessories.

1. One Line Diagram: Indicating system configuration indicating panels, number and type of switches or devices.
  2. Include typical wiring diagrams for each component.
  3. Plans showing locations of all lighting control devices, and associated coverage patterns.
  4. Relay Panel Schedules including circuit breaker origination, load description, and auxiliary control inputs.
- C. Product Data: Submit manufacturer's standard product data for each system component.
- D. Manufacturer's Installation Instructions: Submit for each system component.
- E. Manufacturer's Certificate: Certify Products and system meet or exceed specified requirements.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record the following information:
1. Actual locations of components and record circuiting and switching arrangements.
  2. Wiring diagrams reflecting field installed conditions with identified and numbered, system components and devices.
- B. Operation and Maintenance Data:
1. Submit replacement parts numbers.
  2. Submit manufacturer's published installation instructions and operating instructions.
  3. Recommended renewal parts list.
  4. Product Components and System Warranty Information.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept components on site in manufacturer's packaging. Inspect for damage.
- B. Protect components by storing in manufacturer's containers indoor protected from weather.

#### 1.8 WARRANTY

- A. Furnish five year manufacturer warranty for all control devices and panels.

#### 1.9 EXTRA MATERIALS

- A. Furnish two of each switch type.

- B. Furnish two of each occupancy sensor type.
- C. Furnish two of each photocell type.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Lighting Controls Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Lutron
  - 2. Wattstopper
  - 3. Hubbell Automation
  - 4. Leviton
  - 5. nLight
  - 6. Cooper

### 2.2 REMOTE CONTROL LIGHTING RELAYS

- A. Product Description: Heavy duty, single-coil momentary contact mechanically held remote control relays.
- B. Contacts: Rated 20 amperes at listed voltage. Rated for lighting applications with LED fixtures.
- C. Line Voltage Connections: Clamp type screw terminals.
- D. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard enamel.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.

### 2.3 LIGHTING CONTACTORS

- A. Manufacturers:
  - 1. GE
  - 2. Cutler-Hammer
  - 3. Square D
  - 4. Siemens
- B. Product Description: NEMA ICS 2, magnetic lighting contactor.
- C. Configuration: Mechanically held.
- D. Coil Operating Voltage: 120 volts, 60 Hertz.
- E. Poles: To match circuit configuration and control function.

- F. Contact Rating: Conductor overcurrent protection, considering derating for continuous loads.
- G. Accessories:
  - 1. Cover Mounted Pilot Devices: NEMA ICS 5, standard-duty type with Form Z contacts.
  - 2. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
  - 3. Indicating Light: Red.
  - 4. Relays: NEMA ICS 2.
  - 5. Control Power Transformers: 120 volt secondary, in each enclosed contactor. Furnish fused [primary and] secondary, and bond unfused leg of secondary to enclosure.
- H. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.

## 2.4 SWITCHES

- A. Wall Switch: Specification Grade, momentary pushbutton type for overriding relays.
  - 1. Color: See wiring devices Section 26 27 26.
- B. Switch may be low-voltage type, tied to lighting control system, or line-voltage type with integral relay. See plans for additional information on lighting control scheme.

## 2.5 SWITCH PLATES

- A. Product Description: Specification Grade.
  - 1. Color: See wiring devices Section 26 27 26.

## 2.6 OCCUPANCY / VACANCY SENSOR

- A. Sensors shall be field selectable for either Occupancy Sensing or Vacancy Sensing.
- B. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 20 minutes.
- C. Furnish with manual override.
- D. Operation: Silent.
- E. Room Sensors: Direction or Omni-Direction with coverage pattern as required to cover 100% of space.

## 2.7 PHOTOCELLS

- A. Interior: Provide closed loop sensor mounted as required to provide accurate measurements within the daylighting zone.

- B. Exterior: Rated for exterior lighting voltage as indicated on plan. Mount high on wall and aim north.
- C. Sensor Devices: Each sensor employs photo diode technology to allow linear response to daylight within illuminance range.
  - 1. Exterior Lighting: Hooded sensor, horizontally mounted, employing flat lens, and working range. Entire sensor encased in optically clear epoxy resin.
    - a. Range shall be 1-5 fc to close circuit, 3-15fc to open circuit.
    - b. Sensor shall have up to a 2-minute time delay for both close and open feature.
  - 2. Indoor Lighting: Sensor shall measure both the daylight contribution and the controlled electric light contribution.
    - a. Photocell shall have an extremely linear response with greater than 1% accuracy over the sensed range.
    - b. Photosensor shall utilize an internal photocell that measures only in the visible spectrum and has a response curve that closely matches the photopic curve. The photocell shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
    - c. Photosensor shall provide dimming over the full range.
    - d. Photosensor shall have a control range of 20-60 footcandles.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Provide electrical connection to relay panels, time clocks, or other controllers that require powered connections. Coordinate all connection points with system shop drawings.
- B. Mount switches, occupancy sensors, and photocells to provide system control to match scheme indicated on drawings.
- C. Occupancy / Vacancy Sensors shall be located and shielded as required to optimally cover 100% of the space and prevent nuisance detection from outside of the room.
- D. Install wiring in accordance with Section 26 05 19 and manufacturers written instructions.
- E. Label each low voltage wire clearly indicating connecting relay panel.
- F. Mount relay as indicated on final shop drawings. Wire numbered relays in panel to control power to each load. Install relays to be accessible. Allow space around relays for ventilation and circulation of air.
- G. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.



- H. Label each low voltage wire with relay number at each switch or sensor.

### 3.2 MANUFACTURER'S FIELD SERVICES

- A. Furnish services for check, test, and start-up. Perform the following services:
  - 1. Check installation of panelboards.
  - 2. Test operation of remote controlled devices.
  - 3. Repair or replace defective components.
  - 4. Manufacturer's factory authorized representative shall start-up and verify a complete fully functional system.
- B. Furnish 4 hours to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 7 days notice to Owner of training date.

### 3.3 ADJUSTING

- A. Test each system component after installation to verify proper operation.
- B. Confirm correct loads are recorded on directory card in each panel.

### 3.4 COMMISSIONING

- A. A commissioning agent will be hired to verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available.
- B. The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent shall accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products.
- C. Commissioning must be completed prior to substantial completion. Punchlists will not be performed until lighting controls are in complete operation.

END OF SECTION 26 09 23

## SECTION 262413 - SWITCHBOARDS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes main switchboards.

#### 1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI C12.1 - Code for Electricity Metering.
  - 2. ANSI C39.1 - Requirements, Electrical Analog Indicating Instruments.
- B. Institute of Electrical and Electronics Engineers:
  - 1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
  - 2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- C. National Electrical Manufacturers Association:
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
  - 4. NEMA PB 2 - Deadfront Distribution Switchboards.
  - 5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- D. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details. Provide single-line diagram showing bussing layout of switchboard.
- B. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.
- C. Test Reports: Indicate results of factory production and field tests.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.
- B. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept switchboards on site. Inspect for damage.
- B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

#### 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

#### 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.9 SEQUENCING

- A. Sequence Work to avoid interferences with building finishes and installation of other products.

### 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 manufacturers:
  - 1. Schneider Electric
  - 2. Eaton
  - 3. GE Electric
  - 4. Siemens

## 2.2 DISTRIBUTION SWITCHBOARDS

- A. Product Description: NEMA PB 2, enclosed switchboard with electrical ratings and configurations as indicated on Drawings.
- B. The switchboard shall be suitable for use as service entrance equipment where indicated on Contract Documents and be labeled in accordance with UL requirements.
- C. Device Mounting:
  - 1. Main Section: Individually mounted and compartmented.
  - 2. Distribution Sections: Panel mounted.
- D. Bus:
  - 1. Material: Copper with silver plating, standard size.
  - 2. Provide a full capacity neutral bus.
  - 3. Connections: Bolted, accessible from front only for maintenance.
  - 4. All bussing shall be fully-rated for the entire length of the switchboard lineup. Tapered bus is not acceptable.
- E. Ground Bus: A 1/4 x 2-inch copper ground bus (minimum) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
- F. Pull Section: 18 inch (450 mm.) width, depth and height to match switchboard. Arrange with pull section on left side of distribution sections of switchboard as viewed from front.
- G. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, insulated and braced for short circuit currents. Furnish continuous current rating per study provided by contractor.
- H. Enclosure: Type 1 - General Purpose. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
- I. Align sections at front and rear.
- J. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
- K. Mimic Bus: Show bussing, connections and devices in single line form on front panels of switchboard using black color factory painting.

## 2.3 WIRING / TERMINATIONS

- A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

- B. Mechanical-type terminals shall be provided for all line and load terminations. Terminals shall be suitable for copper or aluminum conductors rated per 75 degrees C for the size as shown on the drawings. 90 degrees C conductor is permissible but must be sized in accordance with 75 degrees C rated conductor tables.
- C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
- D. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

## 2.4 CIRCUIT BREAKERS

- A. For Circuit breakers rated at 1000 amps and over: Provide low voltage insulated case circuit breaker (UL 489 listed), fixed mounted, and shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors microprocessor-based trip device and trip actuator. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection.
  - 1. Provide individual adjustable solid-state elements as an integral part of the solid-state trip devices for complete system selective coordination. Breakers shall have LSGI settings.
  - 2. Position indicator: Provide an indicator visible from the front of the unit to indicate whether the breaker is open or closed.
  - 3. Trip button: Provide a mechanical trip button accessible from the front of the door to trip the breaker.
  - 4. Padlocking: Include provisions for padlocking the breaker in the open position.
  - 5. Trip devices shall have the following features:
    - a. Trip device in each pole.
    - b. Mechanically and electrically trip free.
    - c. Long time element with adjustable pick-up (minimum of 10 settings)
    - d. Long-delay time (0.5 to 24 seconds).
    - e. Short-delay pick-up setting (1.5x to Max allowable by frame).
    - f. Short-delay time (0.0 seconds up to 0.5 seconds)
    - g. Adjustable instantaneous setting (2x to Max allowable by frame).
    - h. Ground fault element with adjustable pick-up (0.2 -1.0 x In in 0.10x increments) and time (0.1 – 1.0 seconds in 0.10 increments) with selectable flat or I2t curve shaping. Provide selectable options for GF OFF, GF alarm, or GF trip.
    - i. Maintenance setting option to reduce Arc Flash hazards.
  - 6. Restricted Access to adjustable-trip settings on circuit breakers shall be provided with lockable and removable cover over the adjusting means and password protected interface.

- B. For Circuit breakers with frames rated under 1000 amps: Provide micrologic electronic trip type circuit breakers unless specifically noted otherwise.
  - 1. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1 to 0.6 second time delay.
  - 2. Trip units shall have field adjustable tripping characteristics as follows:
    - a. Ampere Setting (Continuous)
    - b. Long time band.
    - c. Short time trip point.
    - d. Short time delay.
    - e. Instantaneous trip point.
  - 3. Restricted Access to adjustable-trip settings on circuit breakers shall be provided with lockable and removable cover over the adjusting means and password protected interface.
- C. Circuit breakers for connection of SPD's, controls, metering components, or other accessories within switchboard may be standard molded case circuit breakers unless recommended otherwise by switchboard manufacturer.
- D. All circuit breaker data and settings shall be visible and accessible through the breaker opening.

## 2.5 SOURCE QUALITY CONTROL

- A. Furnish shop inspection and testing in accordance with NEMA PB 2.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify surface is suitable for switchboard installation.

### 3.2 INSTALLATION

- A. Install in accordance with NEMA PB 2.1.
- B. Provide 4" tall concrete housekeeping pad for mounting switchboard.
- C. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- D. Install breaker circuit directory.
- E. Ground and bond switchboards in accordance with Section 26 05 26.

### 3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.1.

### 3.4 ADJUSTING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Tighten bolted bus connections.
- C. Adjust circuit breaker trip and time delay settings to values as indicated in Over Current Protective Device Study.

### 3.5 LABELING

- A. Install engraved plastic nameplates in accordance with Section 26 05 53 on top frame of each section.
- B. Install engraved plastic nameplates in accordance with Section 26 05 53.
  - 1. Provide a nameplate on main section indicating the following:
    - a. Panel Name
    - b. Voltage, Phase, Wire, Short Circuit Current Rating
    - c. Date Installed
  - 2. Provide a nameplate at each branch breaker indicating load it serves.
- C. Install breaker circuit directory.
  - 1. Identify load served and location by room names assigned by user, not by room numbers on floor plans.
  - 2. Note spares and spaces as such. Spare circuit breakers shall be left in the open position.
- D. Provide ARC flash identification per NFPA 70E and Clemson Standards. ARC Flash levels shall be provided per the ARC Flash study provided by the engineer.

### 3.6 CLEANING

- A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

## SECTION 26 24 16 - PANELBOARDS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes distribution and branch circuit panelboards.

#### 1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
  - 1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association:
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
  - 3. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
  - 4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
  - 5. NEMA PB 1 - Panelboards.
  - 6. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- C. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- D. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
- E. Underwriters Laboratories Inc.:
  - 1. UL 67 - Safety for Panelboards.
  - 2. UL 1283 - Electromagnetic Interference Filters.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Include all of the following information:
  - 1. Indicate outline and support point dimensions.
  - 2. Product data
  - 3. Enclosure type
  - 4. Circuit directory
  - 5. Circuit Breaker trip curves
  - 6. Bussing Diagrams
  - 7. Integrated short circuit ampere rating
  - 8. Electrical Room Layout Drawings and Elevations



- 9. Device Nameplate Data
- 10. Schematic Wiring Diagrams

B. Product Data: Submit catalog data showing specified features of standard products.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.
- B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.6 MAINTENANCE MATERIALS

- A. Furnish two of each panelboard key.

### 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 manufacturers:
  - 1. GE Electric
  - 2. Square D
  - 3. Eaton
  - 4. Siemens

#### 2.2 DISTRIBUTION PANELBOARDS

- A. Product Description: NEMA PB 1, circuit breaker type panelboard.
- B. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper and neutral ground bus in each panelboard.
- C. See circuit breaker section below for information on types of circuits required.
- D. Enclosure: NEMA PB 1
  - 1. Indoor Locations - Type 1, unless noted otherwise below.
  - 2. Outdoor Locations - Type 3R.

- E. Cabinet Front: Door-in-door type, fastened with concealed trim clamps, hinged door with flush lock all keyed alike, metal directory frame, finished in manufacturer's standard gray enamel.
- F. Minimum wiring gutter space shall be 4" wide by 5" deep on all four sides.
- G. All panelboard covers shall be hinged "door in door" type with:
  - 1. Front trim shall be single sheet full-finished, code gauge, sheet steel. Door opening shall expose only the operating handles of the circuit breakers.
  - 2. Interior hinged door with hand operated latch or latches as required to provide access to circuit breaker operating handles only, not to energized parts.
  - 3. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips or other fasteners requiring a tool for entry, hand operated latches are not acceptable.
  - 4. Both inner and outer doors shall open left to right.
- H. All panelboards shall have bolt-on style breakers.
- I. Provisions for future breakers shall be fully bussed complete with all necessary mounting hardware.
- J. Provide labeling on panelboard such that each 1.5" space is numbered. This may imply that larger breakers may take up more than 3-spaces.
- K. Provide a coat of rust inhibiting primer, followed by paint to match the adjacent wall surface for front trim and door.

## 2.3 BRANCH CIRCUIT PANELBOARDS

- A. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
- B. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground and neutral bus in each panelboard.
- C. See circuit breaker section below for information on types of circuits required.
- D. Enclosure: NEMA PB 1
  - 1. Indoor Locations - Type 1, unless noted otherwise below.
  - 2. Outdoor Locations - Type 3R.
- E. Cabinet Box: 6 inches (153 mm) deep, 20 inches (508 mm) wide.
- F. Cabinet Front: Door-in-door type, fastened with concealed trim clamps, hinged door with flush lock all keyed alike, metal directory frame, finished in manufacturer's standard gray enamel.
- G. All panelboards shall be hinged "door in door" type with:

1. Interior hinged door with hand operated latch or latches as required to provide access to circuit breaker operating handles only, not to energized parts.
  2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips or other fasteners requiring a tool for entry, hand operated latches are not acceptable.
  3. Both inner and outer doors shall open left to right.
- H. All panelboards shall have bolt-on style breakers.
- I. Provisions for future breakers shall be fully bussed complete with all necessary mounting hardware.

## 2.4 CIRCUIT BREAKERS

- A. For Circuit breakers rated at 1000 amps and over: Provide low voltage AC power circuit breaker, with fixed mounting, stored energy and solid state trip devices.
1. Provide individual adjustable solid-state elements as an integral part of the solid-state trip devices for complete system selective coordination. Breakers shall have LSGI settings.
  2. Position indicator: Provide an indicator visible from the front of the unit to indicate whether the breaker is open or closed.
  3. Trip button: Provide a mechanical trip button accessible from the front of the door to trip the breaker.
  4. Padlocking: Include provisions for padlocking the breaker in the open position.
  5. Trip devices shall have the following features:
    - a. Trip device in each pole.
    - b. Metering, voltage, current memory and LED display.
    - c. Mechanically and electrically trip free.
    - d. Long time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.
    - e. Short time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.
    - f. Ground fault element with adjustable pick-up and selective maximum, intermediate and minimum time delay bands.
    - g. Maintenance setting option to reduce Arc Flash hazards.
- B. For Circuit breakers rated over 200 amps: Provide adjustable trip molded case, solid state adjustable trip type circuit breakers.
1. Ground-Fault Equipment Protection (GFEP) Circuit Breakers (where scheduled): Class B ground-fault protection (30-mA trip).
  2. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  3. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [without intentional] [with field-adjustable 0.1 to 0.6 second] time delay.
  4. Trip units shall have field adjustable tripping characteristics as follows:
    - a. Ampere Setting (Continuous)
    - b. Long time band.
    - c. Short time trip point.
    - d. Short time delay.

- e. Instantaneous trip point.
- C. For all circuit breakers 200 amps and smaller: Provide Molded Case Thermal Magnetic Trip Type Circuit Breakers.
  - 1. Type SWD for lighting circuits.
  - 2. Type HACR for all air conditioning equipment circuits.
  - 3. Class A ground fault interrupter circuit breakers where scheduled.
  - 4. Do not use tandem circuit breakers.
  - 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240 volt, single-pole configuration for all residential applications.
  - 6. GFCI Circuit breakers: Single and two-pole configurations with Class A ground-fault protection (6-mA trip).

## 2.5 SHORT CIRCUIT CURRENT RATING

- A. Devices which achieve the level of fault protection indicated by means of "series" or "integrated" rating shall be acceptable unless specifically indicated on the drawings. All panelboards shall be fully rated.
- B. For existing equipment, provide circuit breakers with short circuit current ratings that match ratings indicated on panel, if no markings indicate panelboard rating, then provide ratings that match highest rated circuit breaker in panelboard.

## PART 3 EXECUTION

### 3.1 EXISTING WORK

- A. Disconnect abandoned panelboards. Remove abandoned equipment unless specifically noted otherwise.
- B. Maintain access to existing panelboards remaining active and requiring access. Modify installation or provide access panel.
- C. Clean and repair existing panelboards to remain.

### 3.2 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1.
- B. Install panelboards plumb.
- C. Install recessed panelboards flush with wall finishes.
- D. Height: 6 feet (1800 mm) to top of panelboard; install panelboards taller than 6 feet (1800 mm) with bottom no more than 4 inches (100 mm) above floor.
- E. Install filler plates for unused spaces in panelboards.

- F. Install spare conduits out of each recessed panelboard to accessible location above ceiling. Minimum spare conduits: 5 empty 1 inch (DN27). Identify each as SPARE.
- G. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.
- H. Provide a circuit breaker locking device for all circuit breakers that serve fire alarm system panels and power supplies. These circuit breakers shall be locked in the "closed" position. Identify these circuit breakers with a red marking.

### 3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

### 3.4 ADJUSTING

- A. Adjust the breaker trip set points per the values provided per the Overcurrent protective device coordination study provided by the engineer.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- C. Touch-up scratched or marred surfaces to match original finish.
- D. Clean all debris from panel interiors.

### 3.5 LABELING

- A. Install engraved plastic nameplates in accordance with Section 26 05 53 on outside top of door frame.
- B. Provide nameplates on all new electrical panelboards. Indicate the following information on the nameplate:
  - 1. Panel Name
  - 2. Panel fed from
  - 3. Voltage, Phase, Wire, Short Circuit Current Rating
  - 4. Date Installed
- C. Use the following color coding for panelboard nameplates:
  - 1. Normal Power: White with Black Letters.
  - 2. Emergency Life Safety: Red with White Letters.
  - 3. Standby Panels: Yellow with White Letters.
- D. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.

- E. Identify load served and location by room names assigned by user, not by room numbers on floor plans. Note spares and spaces as such. Spare circuit breakers shall be left in the open position.
- F. Provide ARC flash identification per NFPA 70E. ARC Flash levels shall be provided per the ARC Flash study provided by the engineer.

### 3.6 CLEARANCE AND WORKSPACE

- A. Maintain workspace and clearances as required by the NEC for voltages encountered. No pipes or ducts shall pass above the outline of the panelboard. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 26 24 16

## SECTION 26 24 17 – COORDINATION PANELBOARDS - FUSIBLE

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes coordination type fusible panelboards if required for fully selectively coordinated distribution systems.

#### 1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
  - 1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association:
  - 1. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
  - 2. NEMA PB 1 - Panelboards.
  - 3. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- C. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- D. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
- E. Underwriters Laboratories Inc.:
  - 1. UL 67 - Safety for Panelboards.
  - 2. UL 98 – Fusible Switches
  - 3. UL 1283 - Electromagnetic Interference Filters.
- F. Federal Specification
  - 1. WP-115c – Panel, Power Distribution.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Include all of the following information:
  - 1. Indicate outline and support point dimensions.
  - 2. Product data
  - 3. Enclosure type
  - 4. Circuit directory
  - 5. Fuse trip curves
  - 6. Bussing Diagrams
  - 7. Integrated short circuit ampere rating
  - 8. Electrical Room Layout Drawings and Elevations

- 9. Device Nameplate Data
- 10. Schematic Wiring Diagrams

B. Product Data: Submit catalog data showing specified features of standard products.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.
- B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.
- B. The assembly and the major components within the assembly shall be the products of a single manufacturer.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- D. Provide Seismic qualified equipment as follows:
  - 1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the 2018 International Building Code (IBC). Equipment certification acceptance criteria shall be based upon the ability for the equipment to be returned to service immediately after a seismic event within the above requirements without the need for repairs.
  - 2. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
    - a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.
    - b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
    - c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.



## 1.6 SYSTEM REQUIREMENTS

- A. Panelboard overcurrent protective devices shall be selectively coordinated with all supply side overcurrent protective devices as required for this project by the 2017 National Electrical Code/NFPA 70 Articles 620.62, 645.27, 700.32, 701.27 and 708.54.
- B. The panelboards shall be UL listed.

## 1.7 MAINTENANCE MATERIALS

- A. Furnish two of each panelboard key.
- B. Furnish a minimum of three spare fuses for each type and size included in panel.

## 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 manufacturers:
  - 1. GE Electric
  - 2. Square D
  - 3. Eaton
  - 4. Siemens

### 2.2 RATINGS

- A. Product Description: NEMA PB1, fusible switch type, lighting and appliance branch circuit panelboard.
- B. Panelboards shall be fully rated for use in systems up to 600VAC with available short circuit current of 200kA RMS symmetrical.
- C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper and neutral ground bus in each panelboard.
  - 1. A system ground bus shall be included in all panels.
  - 2. Full-size (100%-rated) insulated neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200%-rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.
- D. Panelboard main rating shall be available up to and including 400A.
- E. Panelboards shall be labeled with a UL short-circuit rating.

- F. Enclosure: NEMA PB 1
  - 1. Indoor Locations - Type 1, unless noted otherwise below.
- G. Interiors shall be completely factory assembled. They shall be designed such that switching units and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- H. Cabinet Front: Door-in-door type, fastened with concealed trim clamps, hinged door with flush lock all keyed alike, metal directory frame, finished in manufacturer's standard gray enamel.
  - 1. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
- I. Minimum wiring gutter space shall be 4" wide by 5" deep on all four sides.
- J. All panelboard covers shall be hinged "door in door" type with:
  - 1. Front trim shall be single sheet full-finished, code gauge, sheet steel. Door opening shall expose only the operating handles of the switches.
  - 2. Interior hinged door with hand operated latch or latches as required to provide access to circuit breaker operating handles only, not to energized parts.
  - 3. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips or other fasteners requiring a tool for entry, hand operated latches are not acceptable.
  - 4. Both inner and outer doors shall open left to right.
- K. Provisions for future switches shall be fully bussed complete with all necessary mounting hardware.
- L. Provide a coat of rust inhibiting primer, followed by paint to match the adjacent wall surface for front trim and door.
- M. Panelboard shall have an integrated spare fuse compartment for up to (6) spare fuses as standard.
- N. Branch circuit disconnecting means shall be bolt-on type switches with fuses utilized for overcurrent protection. Ratings shall be available from 15-100A with minimum interrupting rating of 300kA symmetrical and 200kA short circuit current assembly rating.
- O. Branch circuit devices shall include a non-defeatable interlock to prevent removal of fuse under load. Provide a fuse ampacity rejection feature to prevent overfusing of branch circuits. Fuses shall be indicating type with permanently installed neon indicating light. Branch devices shall be finger-safe when panelboard trim is removed. Provide lockout/tagout provision for each branch circuit position.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1.
- B. Install panelboards plumb.
- C. Install recessed panelboards flush with wall finishes.
- D. Height: 6 feet (1800 mm) to top of panelboard; install panelboards taller than 6 feet (1800 mm) with bottom no more than 4 inches (100 mm) above floor.
- E. Install filler plates for unused spaces in panelboards.
- F. Install spare conduits out of each recessed panelboard to accessible location above ceiling. Minimum spare conduits: 5 empty 1 inch (DN27). Identify each as SPARE.
- G. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.
- H. Provide a switch locking device for all circuit breakers that serve fire alarm system panels and power supplies. These switches shall be locked in the "closed" position. Identify these circuit breakers with a red marking.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.

### 3.3 ADJUSTING

- A. Touch-up scratched or marred surfaces to match original finish.
- B. Clean all debris from panel interiors.

### 3.4 LABELING

- A. Install engraved plastic nameplates in accordance with Section 26 05 53 on outside top of door frame.
- B. Provide nameplates on all new electrical panelboards. Indicate the following information on the nameplate:
  - 1. Panel Name
  - 2. Panel fed from
  - 3. Voltage, Phase, Wire, Short Circuit Current Rating
  - 4. Date Installed
- C. Use the following color coding for panelboard nameplates:
  - 1. Normal Power: White with Black Letters.

2. Emergency Life Safety: Red with White Letters.
  3. Standby: Yellow with White Letters.
- D. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect any circuiting changes during installation.
- E. Identify load served and location by room names assigned by user, not by room numbers on floor plans. Note spares and spaces as such. Spare switches shall be left in the open position.
- F. Provide ARC flash identification per NFPA 70E. ARC Flash levels shall be provided per the ARC Flash study provided by the engineer.

### 3.5 CLEARANCE AND WORKSPACE

- A. Maintain workspace and clearances as required by the NEC for voltages encountered. No pipes or ducts shall pass above the outline of the panelboard. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 26 24 16

## SECTION 26 25 00 - ENCLOSED BUS ASSEMBLIES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes busway and fittings including plug-in units.

#### 1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
  - 1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association:
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 2. NEMA BU 1 - Busways.
  - 3. NEMA BU 1.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less.
  - 4. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
  - 6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- C. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Indicate ratings, dimensions and finishes. Include dimensioned layout diagram; installation details; locations of [supports and] fittings; and firestops and weatherseals at penetrations. Include details of wall and floor penetrations.
- B. Product Data: Submit catalog data for components and plug-in units.
- C. Coordination Drawings: Indicate busway layout, support locations, and direction connections to equipment (switchboards, transformers, motor control centers, etc.).

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of busway routing and location of plug-in units.
- B. Operation and Maintenance Data: Submit joint re-tightening schedule.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

## 1.6 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.
- B. Convene prior to performing field measurements for busway fabrication drawings.
- C. Review proposed routing, sequence of installation, and protection requirements for installed busway.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle in accordance with NEMA BU 1.1 and manufacturer's written instructions.
- B. Protect from moisture by using appropriate coverings. Store in dry interior locations.

## 1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install indoor busway until building is closed in and suitable temperature conditions are controlled.
- B. Conform to NEMA BU 1 service conditions during and after installation of busway.

## 1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## 1.10 SEQUENCING

- A. Sequence Work to avoid interferences with existing conditions, building finishes and installation of other products.

# 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 manufacturers:
  - 1. GE Electric
  - 2. Square D
  - 3. Eaton
  - 4. Siemens

## 2.2 PLUG-IN BUSWAY

- A. Product Description: NEMA BU 1, 3 phase, 4 wire low impedance plug-in busway.
  - 1. Splash Resistant tested to IEC 60529 standard and rated as IP54.
  - 2. Voltage: 120/208 volts, 60 Hz as noted on drawings.
  - 3. Plug-in Openings: 24 inch (610 mm) centers each side, with hinged doors to protect opening where plug-in unit is not installed.
  - 4. Ampere Ratings: As indicated on Drawings.
  - 5. Full neutral.
  - 6. Ground bus.
- B. Conductors: Copper bars, fully insulated except at joints.
- C. Joints: Single bolt type, with silver-plated contact surface for bus and splice plate.
- D. Fittings: According to manufacturer's recommendations.
- E. Finish: Manufacturer's standard gray enamel.

## 2.3 INDOOR FEEDER BUSWAY

- A. Product Description: NEMA BU1, 3 phase, 4 wire enclosed busway.
  - 1. Splash Resistant tested to IEC 60529 standard and rated as IP54.
  - 2. Voltage: 120/208 volts, 60 Hz.
  - 3. Ampere Ratings: As indicated on Drawings.
  - 4. Full neutral.
  - 5. Ground bus.
- B. Conductors: Copper bars, fully insulated except at joints.
- C. Joints: Single bolt type, with silver-plated contact surface for bus and splice plate.
- D. Fittings: According to manufacturer's recommendations.
- E. Finish: Manufacturer's standard gray enamel.

## 2.4 PLUG-IN UNITS

- A. Product Description: Switching and overcurrent protection in enclosure with hinged door and externally-operatable handle, lockable in OFF position; interlock to prevent opening front cover with switch in ON position.
  - 1. Molded Case Thermal-Magnetic Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

## 2.5 SOURCE QUALITY CONTROL

- A. Inspect and test according to NEMA BU1.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with NEMA BU1.1.
- B. Tighten joints using torque wrench, to manufacturer's specified values.
- C. Install busway length with expansion fitting at each location where busway run crosses building expansion joint.
- D. Support busway as recommended by manufacturer. Support vertical riser at each floor.
- E. Install busway with integral fire stops located where busway penetrates fire-rated walls and floors. Seal around opening to maintain fire-rating equal to wall or floor rating.
- F. Install concrete curb around interior floor penetrations per NEC 368.10(C)(2).
- G. Install engraved plastic nameplates in accordance with Section 26 05 53.
- H. Ground and bond busway in accordance with Section 26 05 26.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.4.

END OF SECTION 26 25 00



## SECTION 26 27 26 - WIRING DEVICES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA WD 1 - General Requirements for Wiring Devices.
  - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

#### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

#### 1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.5 EXTRA MATERIALS

- A. Furnish two of each style, size, and finish wall plate.

### 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 manufacturers:
  - 1. Hubbell
  - 2. Leviton
  - 3. Pass & Seymour

#### 2.2 WALL SWITCHES

- A. Product Description: NEMA WD 1, Heavy-Duty, AC only general-use snap switch.
- B. Body and Handle: Plastic with toggle handle. Color as selected by architect.
- C. Locator Light: Lighted handle type switch; red color handle.

- D. Switch shall be capable of side and back wiring.
- E. Ratings: Match branch circuit and load characteristics.

## 2.3 MOTOR RATED SWITCHES

- A. Product Description: Heavy-Duty, AC type snap switch.
- B. Body and Handle: Plastic with toggle handle. Color to match other devices.
- C. Provide lockout accessory (Garvin Industries: TOGLOK or equal) installed on all motor-rated toggle switches.
- D. Ratings: Match branch circuit and load characteristics.

## 2.4 WALL DIMMERS

- A. Product Description: NEMA WD 1; Type or Style as indicated on Drawings.
- B. Type must be listed as compatible by the manufacturer with the ballast or driver supporting associated fixtures.
- C. Body and Handle: Plastic with linear slide. Color as selected by architect.
- D. Power Rating: Match load shown on drawings; 600 watts minimum. Contractor is responsible for updating loads based on lighting substitutions from basis of design.
- E. Accessory Wall Switch: Match dimmer appearance.

## 2.5 RECEPTACLES

- A. Product Description: NEMA WD 1, Commercial Specification Grade receptacle.
- B. Configuration: NEMA WD 6, type as specified.
- C. GFCI Receptacle (2015 UL 943): Duplex receptacle with integral self-test ground fault circuit interrupter to meet regulatory requirements. Self-test system conducts an automatic test every 15 minutes minimum. If device fails the self-test, visual and audible indicators provide an alert and power to unit is disconnected.
  - 1. GFCI receptacles shall not be used as feed through devices.
  - 2. Where devices are installed behind equipment where not easily accessible, a dead-front GFCI device may be used with a standard device for GFCI protection. See plans for additional information.
  - 3. Where installed in wet locations, the device shall be listed weather resistant type.
- D. USB Receptacle: Duplex receptacle with two integral USB power chargers where indicated on drawings. Complies with the requirements of UL498. USB system shall support the following:
  - 1. Minimum of 3 Amps total capacity.

- 2. Compatible with USB 2.0 and 3.0 devices.
  - E. Receptacle installed outdoors shall be listed as Weather-Resistant “WR” type.
  - F. All Receptacle types shall be NEMA 5-20 unless noted specifically noted otherwise.
  - G. Device Body: Plastic. Color as selected by architect. Emergency power devices shall be defined by a different color. Generator-backed devices shall be red in color. UPS-backed devices shall be blue in color.
  - H. Special Purpose Receptacles: Provide heavy-duty type as indicated on the drawings.
- 2.6 WALL PLATES
- A. Decorative Cover Plate: Smooth stainless steel with engraving indicating panel and branch circuit that serves the device.
  - B. Weatherproof Cover Plate: All devices installed outdoors and indoor devices specifically indicated, shall be provided with weatherproof covers. Covers shall be of the type that maintain weatherproof integrity when in-use and not in-use, as required by the NEC.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and completely covered by wall plates.
- C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

### 3.2 PREPARATION

- A. Clean debris from outlet boxes.

### 3.3 EXISTING WORK

- A. Disconnect and remove abandoned wiring devices.
- B. Modify installation to maintain access to existing wiring devices to remain active.
- C. Clean and repair existing wiring devices to remain or to be reinstalled.

### 3.4 INSTALLATION

- A. Install devices plumb and level.

- B. Install switches with OFF position down.
- C. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- D. Do not share neutral conductor on load side of dimmers.
- E. Install receptacles with grounding pole on bottom.
- F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- H. Use crimp on fork terminals for device terminations using stranded wire. Do not place bare stranded conductors directly under device screws.
- I. Use jumbo size plates for outlets installed in masonry walls.
- J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

### 3.5 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate with equipment shop drawings for devices such as drinking fountains, hand dryers, other appliances, etc. such that devices are located concealed behind appliances and/or maintenance panels unless specifically noted otherwise. Where GFCI protection is required, provide remote means for GFCI protection (circuit breaker unless noted otherwise).
- B. Coordinate locations of outlet boxes provided under Section 26 05 33 and as indicated on drawings.
- C. Coordinate installation of wiring devices with floor box service fittings provided under Section 26 05 34.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 26 27 26

## SECTION 26 28 13 - FUSES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes fuses and spare fuse cabinet.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.

#### 1.3 FUSE PERFORMANCE REQUIREMENTS

- A. Main Service Switches Less than or equal to 600 amperes: Class J
- B. Motor Branch Circuits: Class RK5.
- C. Lighting Branch Circuits: Class G.

#### 1.4 SUBMITTALS

- A. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.7 MAINTENANCE MATERIALS

- A. Furnish one fuse pullers for each size fuse installed.

#### 1.8 EXTRA MATERIALS

- A. Furnish three spare fuses of each Class, size, and rating installed.

### PART 2 PRODUCTS

#### 2.1 FUSES

- A. Manufacturers:

1. Cooper Bussmann.
2. Ferraz Shawmut.
3. Littelfuse.
4. Substitutions: Division 01 Specifications - Product Requirements.

B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated.

C. Voltage: Rating suitable for circuit phase-to-phase voltage.

## 2.2 SPARE FUSE CABINET

A. Product Description: Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified.

B. Doors:Hinged, with hasp for Owner's padlock.

C. Finish: Gray enamel.

## PART 3 EXECUTION

### 3.1 EXISTING WORK

A. Remove fuses from abandoned circuits.

B. Maintain access to existing fuses and other installations remaining active and requiring access. Modify installation or provide access panel.

### 3.2 INSTALLATION

A. Install fuse with label oriented so manufacturer, type, and size are easily read.

B. Install spare fuse cabinet in main electrical room.

END OF SECTION 26 28 13

## SECTION 26 28 19 - ENCLOSED SWITCHES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes fusible and nonfusible switches.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Switch ratings (Voltage, Amperage, Poles, SSCR)
  - 2. Enclosure type and dimensions.
  - 3. Control Wiring Diagrams

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

### 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 manufacturers:
  - 1. GE Electric
  - 2. Square D
  - 3. Eaton
  - 4. Siemens



## 2.2 FUSIBLE SWITCH ASSEMBLIES

- A. Product Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.
- B. Fuse clips: Designed to accommodate NEMA FU 1, Class fuses as defined for application in Section 26 28 13.
- C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.
- D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
- E. Furnish switches with entirely copper current carrying parts.

## 2.3 NONFUSIBLE SWITCH ASSEMBLIES

- A. Product Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.
- B. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.
- C. Furnish switches with entirely copper current carrying parts.

## 2.4 SWITCH RATINGS

- A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
- B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (15-600 ampere switches employing appropriate fuse rejection schemes) or protected by Class L fuses (800-1200 ampere).

# PART 3 EXECUTION

## 3.1 EXISTING WORK

- A. Disconnect and remove abandoned enclosed switches.
- B. Maintain access to existing enclosed switches and other installations remaining active and requiring access. Modify installation or provide access panel.

### 3.2 INSTALLATION

- A. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.
- B. Height: 5 feet (1500 mm) to operating handle.
- C. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.

### 3.3 LABELING

- A. Install engraved plastic nameplates in accordance with Section 26 05 53. Nameplates on all switch enclosures wherein circuits are modified or installed shall indicate the following:
  - 1. Equipment Switch Serves
  - 2. Panel and Circuit Switch is served from.
  - 3. Voltage, Phase, Wire, Short Circuit Current Rating
  - 4. Date Installed.
- B. Use the following color coding for switch nameplates:
  - 1. Normal Power: White with Black Letters.
  - 2. Emergency Life Safety: Red with White Letters.
  - 3. Standby: Yellow with White Letters.
- C. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

### 3.4 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION – 26 28 19

## SECTION 26 28 26 ENCLOSED TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes transfer switches in individual enclosures.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.
- B. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. Underwriters Laboratories Inc.:
  - 1. UL 1008 - Transfer Switch Equipment.

#### 1.3 SUBMITTALS

- A. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of enclosed transfer switches.
- B. Operation and Maintenance Data: Submit routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.6 MAINTENANCE SERVICE

- A. Furnish service and maintenance of transfer switches for one year from Date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 AUTOMATIC TRANSFER SWITCH

- A. Manufacturers:
  - 1. ASCO
  - 2. ABB
  - 3. Eaton
  - 4. Equal from Generator Manufacturer.
- B. Product Description: NEMA ICS 10, automatic transfer switch.
- C. Configuration: Electrically operated, mechanically held transfer switch. Switch shall be contactors and not circuit breaker type controls.
- D. Rating: State voltage and current rating and number of poles or “as indicated on drawings”.
- E. Withstand Current Rating: See rating listed on plan, when used with molded case circuit breaker. Coordinate with circuit breakers on utility side in main switchboard. Ensure this is coordinated prior to pricing as it can affect frame size.
- F. Product Features:
  - 1. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, switch position.
  - 2. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
  - 3. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
  - 4. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed.
  - 5. Pre and Post Transfer Signal Accessories for communications with elevator controllers.
  - 6. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value.
  - 7. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 Hertz from rated nominal value.
  - 8. In-Phase Monitor: Inhibit transfer until source and load are within 10 electrical degrees.
- G. Automatic Sequence of Operation (ATS-E - Emergency) :
  - 1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
  - 2. Time Delay To Start Alternate Source Engine Generator: 0 seconds, adjustable.
  - 3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
  - 4. Time Delay Before Transfer to Alternate Power Source: 0 seconds, adjustable.
  - 5. Total time from loss of normal power to transfer to alternate source shall be less than 10-seconds.

6. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
  7. Time Delay Before Transfer to Normal Power: 90 seconds, adjustable; bypass time delay in event of alternate source failure.
  8. Time Delay Before Engine Shut Down: 10 to 30 minutes, adjustable, of unloaded operation.
  9. Engine Exerciser: Start engine every 30 days; run for 30 minutes before shutting down. Bypass exerciser control when normal source fails during exercising period.
- H. Automatic Sequence of Operation (ATS-L – Legally Required Standby):
1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
  2. Time Delay To Start Alternate Source Engine Generator: 0 seconds, adjustable.
  3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
  4. Time Delay Before Transfer to Alternate Power Source: 30 seconds, adjustable.
  5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
  6. Total time from loss of normal power to transfer to alternate source shall be less than 30-seconds.
  7. Time Delay Before Transfer to Normal Power: 90 seconds, adjustable; bypass time delay in event of alternate source failure.
  8. Time Delay Before Engine Shut Down: 10 to 30 minutes, adjustable, of unloaded operation.
  9. Engine Exerciser: Start engine every 30 days; run for 30 minutes before shutting down. Bypass exerciser control when normal source fails during exercising period.
- I. Automatic Sequence of Operation (ATS-S – Optional Standby):
1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
  2. Time Delay To Start Alternate Source Engine Generator: 0 seconds, adjustable.
  3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
  4. Time Delay Before Transfer to Alternate Power Source: 90 seconds, adjustable.
  5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
  6. Total time from loss of normal power to transfer to alternate source shall be less than 120-seconds.
  7. Time Delay Before Transfer to Normal Power: 90 seconds, adjustable; bypass time delay in event of alternate source failure.
  8. Time Delay Before Engine Shut Down: 10 to 30 minutes, adjustable, of unloaded operation.
  9. Engine Exerciser: Start engine every 30 days; run for 30 minutes before shutting down. Bypass exerciser control when normal source fails during exercising period.

- J. Enclosures:
  - 1. Enclosure: ICS 10, Type 1.
  - 2. Finish: Manufacturer's standard enamel.

## 2.2 DUAL PURPOSE DOCKING STATION

- A. Manufacturers:
  - 1. ESL
  - 2. Trystar
  - 3. APT
- B. Product Description: Dual purpose docking station shall be provided for connection to permanent generator, quick connection points for a portable generator as required per NEC 700.3(F) and for quick connection points for portable load bank for testing of permanent generator and permanent connection to building loads.
- C. Product Configuration: Docking station shall consist of a molded case circuit breaker to isolate portable generator connection from permanent generator connection. Provide kirk-key interlock between breaker and portable generator connections such that generator is isolated from building power and portable generator connections.
- D. Enclosure: Pad Mounted NEMA 3R rated enclosure.
  - 1. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
  - 2. NEMA 3R Integrity shall be maintained while temporary cabling is connected during use.
- E. Busbars:
  - 1. Material: Silver-plated copper.
  - 2. Equipment Ground Bus: 50% of phase size and bonded to enclosure.
  - 3. Neutral Bus: 100% of phase bus and isolated from enclosure.
- F. Connectors: Provide Cam-style male connectors (inlets) and cam-style female connectors (outlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. All cam-style connectors shall be color coded. Cam-style connectors shall be provided for each phase and for ground, and shall also be provided for neutral. Temporary generator and Load Bank connectors shall be Camlok style mounted on gland plate.
  - 1. Camlok shall be 16 Series model and color coded according to system voltage requirements.
  - 2. Camlok connections shall be Bus Bar Style, Cabling or Double Set Screw is not acceptable
  - 3. Camlok connection shall be protected against accidental contact while not in use
- G. Permanent Connection shall be factory installed broad range set-screw mechanical type, located behind a physical barrier.
- H. Phase Rotation Monitor Device: Provide factory installed phase monitoring relay (Siemens 3U4512-1AR20 or equal).

- I. Provide factory installed circuit breaker (UL 489 listed) with kirk-key interface to portable generator connections.
  - 1. Breaker shall include arc reduction maintenance switch.
  - 2. Breaker shall be removable for service and maintenance.
- J. An auxiliary contact shall be provided in the circuit breaker controlling the connection from the Permanent Generator to the ATS and shall be factory wired to terminal blocks within the enclosure. The auxiliary contact is provided in compliance with NEC 2017 700.3 (F)(5) which requires a means to activate an annunciator circuit.

## 2.3 SOURCE QUALITY CONTROL

- A. Furnish shop inspection and testing of each transfer switch.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Provide seismically braced wall mount installations per section 260548.
- B. Install housekeeping pads for all floor mounted equipment.
- C. Install engraved plastic nameplates in accordance with Section 26 05 53. Indicate the following information on the nameplate:
  - 1. Transfer Switch Name
  - 2. Normal Source: Switchboard Name and Circuit.
  - 3. Emergency Source: Disconnect Name.
  - 4. Voltage, Phase, Wire, Short Circuit Current Rating
  - 5. Date Installed
- D. Use the following color coding for ATS nameplates:
  - 1. Emergency: Red with White Letters.
  - 2. Legally Required Standby: Yellow with White Letters
  - 3. Optional Standby: Orange with White Letters.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.22.3.

### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Check out transfer switch connections and operations and place in service.

### 3.4 ADJUSTING

- A. Adjust control and sensing devices to achieve specified sequence of operation.

### 3.5 DEMONSTRATION AND TRAINING

- A. Demonstrate operation of transfer switch in normal, and emergency modes.

END OF SECTION 26 28 26



## SECTION 26 32 13 ENGINE GENERATORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes engine generator set, exhaust silencer and fittings, fuel fittings, remote control panels, battery, and charger.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 3. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.
  - 4. NEMA MG 1 - Motors and Generators.
- B. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
  - 1. NFPA 30 - Flammable and Combustible Liquids Code.
  - 2. NFPA 110 - Standard for Emergency and Standby Power Systems.

#### 1.3 SYSTEM DESCRIPTION

- A. Description: Engine generator assembly and accessories to provide source of power for Level 1 and 2 applications in accordance with NFPA 110.
- B. Capacity: As noted on plan, at elevation of site, standby rating using specified engine cooling scheme.

#### 1.4 SUBMITTALS

- A. Engine-generator submittals shall include the following information:
  - 1. Factory published specification sheet.
  - 2. Manufacturer's catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, etc.
  - 3. Dimensional elevation and layout drawings of the generator set, and related accessories.
  - 4. Weights of all equipment.
  - 5. Concrete pad design, layout and stub-up locations of electrical and fuel systems.
  - 6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, battery charger, control panel, and remote alarm indications.
  - 7. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.

8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
  9. Generator resistances, reactances and time constants.
  10. Generator locked rotor motor starting curves.
  11. Manufacturer's documentation showing maximum expected transient voltage and frequency dips, and recovery time during operation of the generator set at the specified site conditions with the specified loads.
  12. Manufacturer's and dealer's written warranty.
- B. Product Data: Submit data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, and vibration isolators.
- C. Test Reports: Indicate results of performance testing.
- D. Manufacturer's Field Reports: Indicate inspections, findings, and recommendations.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions and service manuals for normal operation, routine maintenance, oil sampling and analysis for engine wear, and emergency maintenance procedures.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.7 WARRANTY

- A. Furnish five year parts & labor manufacturer warranty.

#### 1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of engine generator for one year from Date of Substantial Completion.

#### 1.9 MAINTENANCE MATERIALS

- A. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal tool box.
- B. Furnish two of each fuel, oil and air filter element.

## PART 2 - PRODUCTS

### 2.1 ENGINE

- A. Product Description: Air-cooled in-line or V-type, Diesel internal combustion engine.
- B. Rating: Sufficient to operate under 10 percent overload for one hour in ambient.
- C. Fuel System: No. 2 fuel oil.
- D. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- E. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Furnish remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.
- F. Provide load center in generator enclosure to support all auxiliary loads, battery chargers, heaters, convenience receptacles, etc.
- G. Provide two Convenience receptacles mounted inside enclosure accessible from side access doors.
- H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C).
- I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F (43 degrees C). Radiator air flow restriction 0.5 inches of water (1.25 Pa) maximum.
- J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Furnish fuel pressure gage, water temperature gage, and lube oil pressure gage on engine/generator control panel.
- K. Mounting: Furnish unit with suitable spring-type vibration isolators and mount on structural steel base. Steel base shall be connected to concrete pad on site. Contractor / Manufacturer shall provide design for concrete pad based on equipment sizes and weights.
- L. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, enclosure and sub base tank, batteries, battery racks, accessories, and components will withstand seismic forces. Include the following with quotation:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

- b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- M. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

## 2.2 GENERATOR

- A. Manufacturers:
  - 1. CAT.
  - 2. Cummins.
  - 3. Generac.
  - 4. Kohler.
- B. Generator Specifications: The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. The generator shall meet performance class G2 of ISO 8528.
  - 1. The excitation system shall be permanent magnet and enable the alternator to sustain 300% of rated current.
  - 2. Rotor/Stator Temperature rise at 40' Ambient: 105' C
  - 3. Insulation Class H
  - 4. Subtransient Reactance no greater than 12.5%
- C. Digital Voltage Regulator:
  - 1. The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.
  - 2. The voltage regulator shall communicate with the Generator Control Panel via a communication network with generator voltage adjustments made via the controller keypad. Additionally, the controller shall allow system parameter setup and monitoring, and provide fault alarm and shutdown information through the controller. A PC-based user interface shall be available to allow viewing and modifying operating parameters in a windows compatible environment.

## 2.3 GOVERNOR

- A. The engine governor shall be a electronic Engine Control Module (ECM) with 24-volt DC Electric Actuator. The ECM shall be enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. Speed droop shall be adjustable from 0 (isochronous) to 10%, from

no load to full rated load. Steady state frequency regulation shall be +/- 6 RPM. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The ECM shall adjust fuel delivery according to exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

## 2.4 HEAT EXCHANGER

- A. Product Description: Engine or base mounted heat exchanger and expansion tank of type and capacity recommended by engine manufacturer. Furnish solenoid shutoff valve for field installation on cooling water inlet, configured to open when engine runs.

## 2.5 ACCESSORIES

- A. Silencer: A super critical grade silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed inside enclosure (no exception). The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.
- B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries. Match battery voltage to starting system. Furnish cables and clamps.
- C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
- D. Battery Charger: Current limiting type designed to float at 2.17 volts for each cell and equalize at 2.33 volts for each cell. Furnish overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Furnish wall mounted enclosure to meet NEMA 250, Type 1 requirements.
- E. Line Circuit Breaker: Circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole. Furnish battery voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements.
- F. Engine-Generator Digital Electronic Control Panel: NEMA 250, Type 1 generator-mounted control panel enclosure with engine and generator controls and indicators. Furnish provision for padlock and the following equipment and features:
  - 1. Frequency Meter: 45-65 Hz. range, 3.5 inch (89 mm) dial.
  - 2. AC Output Voltmeter: 3.5 inch (89 mm) dial, 2 percent accuracy, with phase selector switch.
  - 3. AC Output Ammeter: 3.5 inch (89 mm) dial, 2 percent accuracy, with phase selector switch.
  - 4. Output voltage adjustment.
  - 5. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.
  - 6. Engine start/stop selector switch.
  - 7. Engine running time meter.

8. Oil pressure gage.
  9. Water temperature gage.
  10. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
  11. Additional visual indicators and alarms in accordance with NFPA 110.
  12. Remote Alarm Contacts: Factory wire SPDT contacts to terminal strip for remote alarm functions in accordance with NFPA 110.
  13. Network monitoring capabilities to support indications of generator run status and general alarm conditions.
- G. Remote Annunciator Panel: Flush mounted panel with painted finish. Furnish audible and visible indicators and alarms in accordance with NFPA 110. Remote annunciator panel shall be located in Fire Command Center.
- H. Weather-protective Enclosure: Reinforced steel housing, with sound attenuation (SPL of 75dBA at 7 meters), allowing access to control panel and service points, with lockable doors and panels. Furnish fixed louvers, double-wall sub-base fuel tank, with overfill and spill protection, battery rack, and silencer.

## 2.6 SOURCE QUALITY CONTROL

- A. Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  2. Full load run.
  3. Maximum power.
  4. Voltage regulation.
  5. Transient and steady-state governing.
  6. Single-step load pickup.
  7. Safety shutdown.
  8. Report factory test results within 10 days of completion of test.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Ground and bond generator and other electrical system components in accordance with Section 26 05 26.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.22.

### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start up engine-generator assembly. Coordinate all start-up and testing activities with the Engineer and Owner.
- B. Provide full load bank test per NFPA 110.

### 3.4 ADJUSTING

- A. Adjust generator output voltage and engine speed to meet specified ratings.

### 3.5 CLEANING

- A. Clean engine and generator surfaces. Replace oil and fuel filters with new.

### 3.6 DEMONSTRATION AND TRAINING

- A. On-Site Training: Factory representative shall provide a minimum of 1 day of owner training in the complete operation and maintenance of the automatic transfer switch system and generator system. Training session for the automatic transfer switch system and generator system shall be scheduled on a separate day from the startup & testing day and shall be scheduled at least two weeks in advance with the Owner and before building acceptance.
- B. Simulate power outage by interrupting normal source, and demonstrate system operates to provide emergency and standby power.

END OF SECTION 26 32 13

## SECTION 26 41 00 FACILITY LIGHTNING PROTECTION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes air terminals, interconnecting conductors, grounding, and bonding for lightning protection.

#### 1.2 REFERENCES

- A. Lightning Protection Institute:
  - 1. LPI 175 - Standard of Installation.
- B. National Fire Protection Association:
  - 1. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- C. Underwriters Laboratories Inc.:
  - 1. UL 96 - Lightning Protection Components.
  - 2. UL 96A - Installation Requirements for Lightning Protection Systems.

#### 1.3 SYSTEM DESCRIPTION

- A. Description: Conductor system protecting entire building and having UL Master Label.

#### 1.4 SUBMITTALS

- A. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
- B. Product Data: Submit catalog sheets showing dimensions and materials of each component, and include indication of listing in accordance with UL 96.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- E. Certificate of Compliance: Submit certificate from Underwriter's Laboratories indicating approval of lightning protection systems.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.



## 1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with UL 96A and furnish Master Label.
- B. Maintain one copy of document on site.

## 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in lightning protection equipment with minimum three years experience.
- B. Installer: Authorized installer of manufacturer with minimum three years documented experience.
- C. Inspection Agency: Underwriter's Laboratories, Inc. (UL).

## 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## 1.9 COORDINATION

- A. Coordinate Work with roofing and exterior and interior finish installations.

# PART 2 - PRODUCTS

## 2.1 COMPONENTS

- A. Product Listing: UL 96.
- B. Air Terminals:
  - 1. Material: Aluminum.
  - 2. Use adhesive base for single-ply roof installations.
  - 3. Grounding Rods: Solid copper.
  - 4. Ground Plate: Copper.
  - 5. Conductors:
    - a. Material: Aluminum.
    - b. Configuration: Cable.
- C. Connectors and Splicers: Aluminum.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install in accordance with UL 96A.

- B. Connect conductors using mechanical connectors. Protect adjacent construction elements and finishes from damage.
- C. Conceal interior conductors within building finishes. Conceal exterior conductors where practical.
- D. Bond exterior metal bodies on building to lightning protection system, and provide intermediate level interconnection loops 60 feet (18 m) on center.
- E. Do not use mechanical system enclosures as the only path from aerials to horizontal conductor runs. Extend conductor up equipment enclosure to aerials. Do not block any access panels, nameplates, or other accessories with conductors.
- F. Provide spring air terminals with blunt tips for mid-roof air terminals.

### 3.2 FIELD QUALITY CONTROL

- A. Perform inspection and testing in accordance with UL 96A.

END OF SECTION 26 41 00

## SECTION 26 43 00 – SURGE PROTECTIVE DEVICES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Surge Protection Devices Type 1 and Type 2 Devices

#### 1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
1. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
  2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
  3. IEEE C62.45 - Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
- B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
  2. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- C. Underwriters Laboratories Inc.:
1. UL 1283 - Electromagnetic Interference Filters.
  2. UL 1449 Third Edition - Surge Protective Devices.

#### 1.3 SUBMITTALS

- A. Division 01 Specifications - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit the following
1. Unit Dimensions and Weights
  2. Wiring configuration.
  3. Warranty Statement
  4. Current Ratings
  5. Clamping Voltages
  6. Response Time
- C. Test Reports:
1. Indicate Let-Through voltage test data.
  2. Submit spectrum analysis of each unit.
  3. Submit test reports from nationally recognized independent testing laboratory verifying suppressors can survive published surge current rating.
- D. Manufacturer's Installation Instructions: Submit installation instructions and connection requirements.
- E. Manufacturer's Certificate: Certify transient voltage surge suppression device complies with UL 1449 Third Edition Surge Voltage Ratings.

#### 1.4 QUALITY ASSURANCE

- A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
  - 1. UL 1449 3rd Edition 2009 Revision
  - 2. UL 1283.
  - 3. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
  - 4. ANSI/IEEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
  - 5. IEEE 1100 Emerald Book.
  - 6. National Fire Protective Association (NFPA 70: National Electrical Code).

## 1.5 WARRANTY

- A. Provide a 5 year product warranty.

## 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 manufacturers:
  - 1. ASCO
  - 2. Current Technologies
  - 3. Ditek
  - 4. GE Electric
  - 5. Square D
  - 6. Eaton

### 2.2 ELECTRICAL REQUIREMENTS

- A. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3<sup>rd</sup> Edition, section 37.7. MCOV values claimed based on the component's value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.
- B. Unit shall have not more than 10% deterioration or degradation of the UL1449 3<sup>rd</sup> Edition Voltage Protective Rating VPR) due to repeated surges. Unit shall have a monitoring option available to be able to test and determine the percentage of protective available at all times.
- C. Protection Modes: SVR(6kV, 500A) and UL1449 3<sup>rd</sup> Edition VPR(6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347) 3-Phase/4 wire and (120/240) Split phase/3 wire circuits shall be as follows and comply with test procedures outlined in UL1449 3<sup>rd</sup> Edition section 37.6

System Voltage	Mode	MCOV	B3 Ringwave	C3 Comb. Wave	UL 1449 Second Edition SVR Rating	UL 1449 Third Edition VPR Rating
120/240 120/208	L-N	150	325/375	650/775	400/400	700/700
	L-G	150	400/450	650/825	500/500	700/700
	N-G	150	350/350	500/500	500/500	900/900
	L-L	300	400/500	950/1250	700/700	900/900
277/480	L-N	320	550/600	1125/1225	900/900	1000/1000
	L-G	320	850/875	1075/1225	1000/1000	1200/1200
	N-G	320	700/700	900/900	800/800	1200/1200
	L-L	550	650/750	1950/2200	1500/1500	1800/1800

- D. Electrical Noise Filter- each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220B insertion loss test method.
1. 100 kHz at 44 db or better.
  2. All other frequencies should be 32 db or better.
- E. Each fuse shall be individually sealed in a manner that eliminates the potential for cross arcing.
- F. Each unit shall provide the following features:
1. Phase Indicator lights, Form C dry contacts, surge counter and audible alarm.
  2. Field testable while installed.
  3. Measuring capability to indicate the percent protective available in SPD.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Each unit shall be installed per Manufacturer's recommended installation and wiring practices.
- B. The UL 1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.
- C. The UL 1449 Nominal Discharge Surge Current Rating shall be a minimum of 20kA.
- D. Surge Current Rating of device shall be as noted on drawings.
- E. The SCCR rating of the SPD shall be 200kAIC without requiring an upstream protective device for safe operation.
- F. Locate SPDs and associated circuit breaker in panelboard or switchboard so as to minimize conductor lengths and bends.
1. Conductors between SPD and circuit breaker shall be no more than 24" in length.
  2. There shall be no sharp bends or kinks in conductors.
  3. Conductors shall be continuous from device to breaker.

4. Do not bundle or tie-wrap conductors together.
  5. If conductor's must exceed 24" in length or contain multiple bends due to location constraints, contractor shall provide manufacturer's specialty cable for excessive lengths at no additional cost.
- G. The SPD manufacturer's technician shall perform a system checkout and start-up in the field to assure proper installation, operation and to initiate the warranty of the system. The technician will be required to do the following:
1. Verify voltage clamping levels using the DTS-2 test equipment.
  2. Verify N-G connection when applicable.
  3. Record information to product signature card for each product installed.

END OF SECTION 26 43 00

## SECTION 26 51 00 - INTERIOR LIGHTING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes interior luminaires, lamps, ballasts, and accessories.

#### 1.2 REFERENCES

- A. Illuminating Engineering Society (IES)
  - 1. LM-79 - Approved Method: electrical and Photometric Testing of Solid-State Lighting Devices.
  - 2. LM-80 - Approved Method: Measuring Lumen Depreciation of LED Light Sources.
  - 3. TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources.
- B. National Electrical Manufacturers Association (NEMA)
  - 1. ANSI/NEMA/ANSI C78.377 - American National Standard for the Chromaticity of Solid State Lighting Products
  - 2. SSL-1 - Electronic Drivers for LED Devices, Arrays, or Systems.
- C. National Fire Protection Association (NFPA)
  - 1. NFPA 70 - National Electrical Code (NEC)
- D. Underwriters laboratories, Inc. (UL)
  - 1. 8750 - Light Emitting Diode (LED) Light Sources for Use in Lighting Products.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.
- B. Product Data: Submit dimensions, ratings, and performance data.
- C. Submittal Data for LED fixtures shall be based on the specified "basis-of-design" fixture and shall include the following:
  - 1. Wattage
  - 2. Color Temperature
  - 3. CRI
  - 4. Distribution Pattern
  - 5. Total Lumen Output for Fixture Assembly based on the data above.
  - 6. Submit US DOE LED Lighting Facts label, or other 3rd party testing reports that include the information above.
- D. Samples:
  - 1. Submit two color chips 3 x 3 inch (75 x 75 mm) in size illustrating luminaire finish color is indicated as custom in luminaire schedule.

2. Provide a sample of each LED fixture indicated in lighting fixture schedule as sample required. Samples shall be available for review by architect and owner prior to completion of order for these specific fixtures in the project. Sample fixture, if approved, may be used and installed in project.
3. Create one sample for each custom fixture type to be reviewed by architect and owner prior to completion of order for fixtures in project. Sample fixture, if approved, may be used and installed in project.

#### 1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.5 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

### PART 2 PRODUCTS

#### 2.1 INTERIOR LUMINAIRES

- A. See Lighting fixture schedule on plans for information on luminaires.
  1. Basis-of-Design Product: The design for each lighting fixture is based on the product named from the first manufacturer listed in the schedule. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified, or a prior approved manufacturer.
  2. A prior approved manufacturer does not specifically approve a fixture. It only indicates that the manufacturer can provide a fixture equal to the specified.
  3. Substitutions: Division 01 Specifications - Product Requirements.
- B. Product Description: Provide complete interior luminaire assemblies, with features, options, and accessories as required to provide a complete working system mounted to or recessed in wall or ceiling system as described on Architectural Reflected Ceiling Plans.
- C. Custom fixtures shall be provided by a manufacturer with a minimum eight years of experience designing custom fixtures. Fixtures shall be UL tested and listed before order is placed for sample. See Submittal section for additional information on samples for custom fixtures. Custom fixtures as a substitute for a specified fixture shall utilize the same materials, finishes, and light engine. LED fixtures shall not be substituted with a fixture that utilized incandescent or halogen sockets with LED replacement lamps.

#### 2.2 LED LUMINAIRES

- A. LED light fixtures shall be in accordance with IES, NFPA, UL standards as shown on the drawings and as specified.
- B. All electrical components shall be RoHS compliant.



- C. LED fixtures shall be complete assemblies. Fixtures designed around a different lamp source with an LED type replacement lamp shall not be accepted.
- D. Lighting shall be completely diffused through internal shielding, or fixture lens. Multiple Individual Diodes shall not be visible through the lens of the fixture.
- E. LED modules shall include the following features unless otherwise indicated:
  - 1. Comply with LM-79 and LM-80 requirements.
  - 2. Minimum CRI of 80 unless otherwise specified in the Lighting Fixture Schedule.
  - 3. Color Temperatures for each fixture shall be enclosed inside a 3-step MacAdam ellipse.
  - 4. Minimum Rated Life: 50,000 hours per IES L70.
  - 5. Total Fixture Light Output in lumens no less than 95% of Lumens listed in Lighting Fixture Schedule.
  - 6. Total Fixture Efficacy in Lumens / Watt no less than 95% of "Basis-of-Design" fixture.
- F. LED drivers, modules, and reflectors shall be accessible for servicing and replacement from below the ceiling.
- G. Active cooling for LED systems shall not be allowed.

## 2.3 LED DRIVERS

- A. LED drivers shall include the following features unless otherwise indicated:
  - 1. Minimum efficiency: 85% at full load.
  - 2. Minimum operating Ambient Temperature: -20° C (-4° F)
  - 3. Include integral short circuit, open circuit, and overload protection.
  - 4. Power Factor:  $\geq 0.95$ .
  - 5. Total Harmonic Distortion:  $\leq 20\%$
- B. Provide dimming drivers where noted on fixture schedule. Dimming systems shall conform to the following:
  - 1. Compatibility: Certified by manufacturer for use with specific dimming control system indicated.
  - 2. Maximum inrush current of 2 amperes for 120V and 277V drivers.
  - 3. Class A sound Rating.
  - 4. Drivers shall track evenly across multiple fixtures at all light levels.
  - 5. Dimming Range shall be continuous from 100 percent to 10 percent relative light output minimum. See drawings for other applications that may require a more stringent dimming range.

## PART 3 EXECUTION

### 3.1 EXISTING WORK

- A. Disconnect and remove abandoned luminaires, lamps, and accessories.

- B. Extend existing interior luminaire installations using materials and methods compatible with existing installations, or as specified.
- C. Clean and repair existing interior luminaires to remain or to be reinstalled.

### 3.2 INSTALLATION

- A. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.
- B. Support luminaires independent of ceiling framing as follows:
  - 1. All lighting fixtures shall be positively attached to the suspended ceiling system by mechanical means as specified in the NEC unless independently supported. The attachment device shall have the capacity of supporting 100% of the lighting fixture weight acting in any direction. A minimum of two attachment devices are required for each fixture.
  - 2. Surface-mounted lighting fixtures shall be attached to the ceiling system with a positive clamping device that completely surround the supporting members. Safety wires shall be attached between the clamping device and the adjacent ceiling hanger to the structure above. In no case shall the fixture exceed the design carrying capacity of the supporting members.
  - 3. Lighting fixtures weighing less than 10 lbs. (5 kg) shall have one (1) slack #12-gauge safety wire connected from the fixture housing (not the detachable end plates) to the structure above.
  - 4. Lighting fixtures weighing less than 56 lbs. (25 kg) shall have two (2) slack #12-gauge safety hanger wires connected from the fixture housing to the structure above. Hanger wires shall be attached on opposite corners of fixture.
  - 5. Lighting fixtures weighing 56 lbs. (25 kg) or more shall be supported directly from the structure above by approved hangers. The ceiling suspension system shall not provide any direct support.
  - 6. Pendant-hung lighting fixtures shall be supported directly from the structure above using no less than #9-gauge wire or an approved alternate support. The ceiling suspension system shall not provide any direct support.
  - 7. Flexible conduit is required for attachment of the fixtures. Direct connection with Rigid or EMT or other hard-piped solution is not allowed.
  - 8. All support wires shall connect directly to structure. Do not connect to support systems for any other systems. Support wires must be arranged so that they are not touching sprinkler piping and would not touch sprinkler piping in the event the ceiling was removed and the cables were the sole support for the fixtures.
  - 9. Paint support wires for lighting fixtures and lighting whips red such that they are easily identified from below.
- C. Locate recessed ceiling luminaires as indicated on Drawings and on architectural reflected ceiling plans.
- D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- E. Install recessed luminaires to permit removal from below.

- F. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- G. Install clips to secure recessed grid-supported luminaires in place.
- H. Install wall-mounted luminaires at height as indicated on Drawings.
- I. Install accessories furnished with each luminaire.
- J. Connect luminaires to branch circuits using flexible conduit.
- K. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- L. Install specified lamps in each luminaire.
- M. Ground and bond interior luminaires in accordance with Section 26 05 26.

### 3.3 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

### 3.4 ADJUSTING

- A. Division 01 Specifications - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Aim and adjust luminaires as indicated on Drawings.

### 3.5 CLEANING

- A. Remove dirt and debris from enclosures.
- B. Clean photometric control surfaces as recommended by manufacturer.
- C. Clean finishes and touch up damage.

### 3.6 PROTECTION OF FINISHED WORK

- A. Repair/replace luminaires having failed components at Substantial Completion.

END OF SECTION 26 51 00

## SECTION 26 52 00 - EMERGENCY LIGHTING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes emergency lighting units and exit signs.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
- B. National Fire Protection Association (NFPA)
  - 1. NFPA 70 - National Electrical Code (NEC)
- C. Underwriter Laboratories (UL)
  - 1. UL1008 – Transfer Switch Equipment

#### 1.3 SUBMITTALS

- A. Product Data: Submit dimensions, ratings, and performance data.

#### 1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

### PART 2 PRODUCTS

#### 2.1 EXIT SIGNS

- A. Manufacturers: See Lighting fixture schedule on plans for information on luminaires.
  - 1. Basis-of-Design Product: The design for each lighting fixture is based on the product named from the first manufacturer listed in the schedule. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified, or a prior approved manufacturer.
  - 2. A prior approved manufacturer does not specifically approve a fixture. It only indicates that the manufacturer can provide a fixture equal to the specified.
  - 3. Substitutions: Division 01 Specifications - Product Requirements.
- B. Product Description: Exit sign fixture.
- C. Housing: As indicated on drawings.
- D. Face: As indicated on Drawings.

- E. Directional Arrows: As indicated on Drawings with Universal type for field adjustment.
- F. Lamps: LED.

## 2.2 EMERGENCY LOAD TRANSFER DEVICE (ELTC)

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following manufacturers:
  - 1. Bodine – GTD Series
  - 2. Iota – ETS Series
  - 3. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: The ballast load transfer control operates automatically on a continuous standby mode. Unit bypasses any electrical control device when normal power fails and emergency generator or inverter power is needed for egress lighting regardless of switching device (standard toggle switch, photo electric cell, time clock, energy management equipment) on/off position. In order to comply with article 700 of the National Electrical Code (NEC) and UL 1008, the ELTC must have the following components:
  - 1. Failsafe continuously monitored relay with contacts instantaneous or time delay electrically operated mechanically latched operation relays opens and closes emergency power with no possibility of current cross over.
  - 2. Test switch required to test under load.
  - 3. Indication LEDs. Unit to have a red LED signal lamp that indicates fixture is on emergency power and that there is power (normal and/or emergency) is connected to device.
  - 4. Provide label that reads “Caution two electrical power sources in this unit.”
  - 5. Unit to have a power link to isolate catastrophic faults internally or external of device. Unit shall be able to withstand direct short to load with no adverse effect to switching device.
  - 6. Device shall include integral Surge protection.
- C. Where 0-10V dimming is indicated on plans, contractor shall provide either a dual relay emergency load transfer device, or two emergency load transfer devices so that dimming signal from emergency fixture is cancelled and fixture illuminates at 100% output.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install suspended exit signs using pendants supported from swivel hangers. Install pendant length required to suspend sign at indicated height.
- B. Install surface-mounted emergency lighting units and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

- C. Install wall-mounted emergency lighting units and exit signs at height as indicated on Drawings.
- D. Install accessories furnished with each emergency lighting unit and exit sign.
- E. Connect emergency lighting units and exit signs to branch circuits as indicated on Drawings.
- F. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.
- G. Ground and bond emergency lighting units and exit signs in accordance with Section 26 05 26.

### 3.2 FIELD QUALITY CONTROL

- A. Operate each unit after installation and connection. Inspect for proper connection and operation.

### 3.3 ADJUSTING

- A. Aim and adjust lamp fixtures as indicated on Drawings.
- B. Position exit sign directional arrows as indicated on Drawings.

### 3.4 PROTECTION OF FINISHED WORK

- A. Repair/replace luminaires having failed components at Substantial Completion.

END OF SECTION – 26 52 00

## SECTION 26 56 00 - EXTERIOR LIGHTING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes exterior luminaires, poles, and accessories.

#### 1.2 REFERENCES

- A. Illuminating Engineering Society (IES)
  - 1. LM-79 - Approved Method: electrical and Photometric Testing of Solid-State Lighting Devices.
  - 2. LM-80 - Approved Method: Measuring Lumen Depreciation of LED Light Sources.
  - 3. TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources.
- B. National Electrical Manufacturers Association (NEMA)
  - 1. ANSI/NEMA/ANSI C78.377 - American National Standard for the Chromaticity of Solid State Lighting Products
  - 2. SSL-1 - Electronic Drivers for LED Devices, Arrays, or Systems.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Indicate dimensions and components for each luminaire.
- B. Product Data: Submit dimensions, ratings, and performance data.
- C. Submittal Data for LED Fixtures shall be based on specified "basis-of-design" fixture and shall include the following:
  - 1. Wattage
  - 2. Color Temperature
  - 3. CRI
  - 4. Distribution Pattern
  - 5. Total Lumen Output for Fixture Assembly based on the data above.
  - 6. Submit US DOE LED Lighting Facts label, or other 3<sup>rd</sup> party testing reports that include the information above.

#### 1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

#### 1.6 COORDINATION

- A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

## PART 2 PRODUCTS

### 2.1 LUMINARIES

- A. See Lighting fixture schedule on plans for information on luminaires.
  - 1. Basis-of-Design Product: The design for each lighting fixture is based on the product named from the first manufacturer listed in the schedule. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified, or a prior approved manufacturer.
  - 2. A prior approved manufacturer does not specifically approve a fixture. It only indicates that the manufacturer can provide a fixture equal to the specified.
- B. Product Description: Provide complete exterior luminaire assemblies, with features, options, and accessories as required to provide a complete working system mounted as described in contract documents.

### 2.2 LED LUMINAIRES

- A. LED light fixtures shall be in accordance with IES, NFPA, UL standards as shown on the drawings and as specified.
- B. All electrical components shall be RoHS compliant.
- C. LED fixtures shall be complete assemblies. Fixtures designed around a different lamp source with an LED type replacement lamp shall not be accepted.
- D. LED modules shall include the following features unless otherwise indicated:
  - 1. Comply with LM-79 and LM-80 requirements.
  - 2. Minimum CRI of 70 unless otherwise specified in the Lighting Fixture Schedule.
  - 3. Color Temperatures for each fixture shall be enclosed inside a 3-step MacAdam ellipse.
  - 4. Minimum Rated Life: 50,000 hours per IES L70.
  - 5. Total Fixture Light Output in lumens shall be no less than 95% of Lumens listed in Lighting Fixture Schedule.
  - 6. Total Fixture Efficacy in Lumens / Watt shall be no less than 95% of "Basis-of-Design" fixture.
- E. LED drivers, modules, and reflectors shall be accessible for servicing and replacement.
- F. Active cooling for LED systems shall not be allowed.

### 2.3 LED DRIVERS

- A. LED drivers shall include the following features unless otherwise indicated:
  - 1. Minimum efficiency: 85% at full load.
  - 2. Minimum operating Ambient Temperature: -20° C (-4° F)
  - 3. Include integral short circuit, open circuit, and overload protection.
  - 4. Power Factor:  $\geq 0.95$ .



5. Total Harmonic Distortion:  $\leq 20\%$
- B. Provide LED drivers with step-dim configuration as noted on plans. Systems shall conform to the following:
  1. Ballast circuit and leads provide for remote control of the light output of the associated lamp(s) between high- and low-level and off.
    - a. High-Level: 100%
    - b. Low-Level: 50%
  2. They distribute even light across all LEDs and boards in entire fixture. Fixture shall not accomplish steps by switching grouped LEDs or boards.
  3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.
- C. Provide dimming drivers where noted on fixture schedule. Dimming systems shall conform to the following:
  1. Compatibility: Certified by manufacturer for use with specific dimming control system indicated.
  2. Maximum inrush current of 2 amperes for 120V and 277V drivers.
  3. Class A sound Rating.
  4. Drivers shall track evenly across multiple fixtures at all light levels.
  5. Dimming Range shall be continuous from 100 percent to 10 percent relative light output minimum. See drawings for other applications that may require a more stringent dimming range.

## 2.4 METAL POLES

- A. Finish: Match Luminaire Finish.
- B. Section Shape and Dimensions: Square pole, as specified on plans.
- C. Base: Standard with 4 anchor bolts and ground lug. Two piece bases are not acceptable.
- D. Accessories:
  1. Access door (handhole) in base with stainless steel allen head screws.
  2. Provide Bussman HEB or equal fuseholder and KTK (480v) / FNB (208v) or equal fuse for each phase conductor in each pole, accessible from handhole.
  3. Provide Littelfuse LSP Series protection module for each pole accessible from handhole.
- E. Foundation: Pole shall be mounted on a concrete foundation with rebar reinforcement. Chamfer edges and fill voids in foundation.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify foundations are ready to receive fixtures.

### 3.2 EXISTING WORK

- A. Disconnect and remove abandoned exterior luminaries.
- B. Extend existing exterior luminaire installations using materials and methods compatible with existing installations, or as specified.
- C. Clean and repair existing exterior luminaries to remain or to be reinstalled.

### 3.3 INSTALLATION

- A. Install concrete bases for lighting poles at locations as indicated on Drawings.
- B. Install poles plumb. Install double nuts to adjust plumb. Grout around each base.
- C. Install lamps in each luminaire.
- D. Bond and ground luminaries ,metal accessories and metal poles in accordance with Section 26 05 26. Install supplementary grounding electrode at each pole.

### 3.4 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- B. Measure illumination levels and submit to engineer for review.
  - 1. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

### 3.5 ADJUSTING

- A. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings and as directed by engineer in the field.

### 3.6 CLEANING

- A. Clean photometric control surfaces as recommended by manufacturer.
- B. Clean finishes and touch up damage.

### 3.7 PROTECTION OF FINISHED WORK

- A. Replace/repair luminaries having failed at Substantial Completion.

END OF SECTION 26 56 00

## SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of an inside plant telecommunication system. All materials shall be new, free from defects, of current manufacture, of the quality specified or shown. Each type of material shall be of the same manufacturer throughout the work. This section includes Inside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System.

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete communications system that is compliant with ANSI/TIA/EIA, NECA/NEIS and ISO/IEC standards as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media.
  - 1. The Structured Cabling System shall be tested for and be capable of 10 Gigabit Ethernet operation as specified in the most recent edition of IEEE 802.3 and its related amendments.
- B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

#### 1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section and to all Division 27 Specification Sections.

#### 1.4 STANDARDS AND CODES

- A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
  - 1. General:
    - a. National Fire Protection Association (NFPA) – NFPA 70: National Electrical Code (NEC)
    - b. National Fire Protection Association (NFPA) – NFPA 101: Life Safety Code
    - c. National Electrical Safety Code (NESC)
    - d. Occupational Safety and Health Act (OSHA)
  - 2. Communications:
    - a. ANSI/TIA - 455TIA-455-25 : Fiber Optic Test Standards
    - b. ANSI/TIA - 526: Optical Fiber Systems Test Procedures

- c. ANSI/TIA - 568.0-E: Generic Telecommunications Cabling for Customer Premises
  - d. ANSI/TIA - 568.1-E: Commercial Building Telecommunications Cabling Standard
  - e. ANSI/TIA – 569-E: Commercial Building Standard for Telecommunication Pathways and Spaces
  - f. ANSI/TIA – 606-D: Administration Standard for Commercial Telecommunications Infrastructure
  - g. ANSI/TIA – 607-D: Commercial Grounding (Earthing) and Bonding for Customer Premises
  - h. ANSI/TIA – 862: Structured Cabling Infrastructure Standard for Intelligent Building Systems
  - i. ANSI/TIA-1152: Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
  - j. ISO/IEC 61935-1: Specification for the Testing of Balanced and Coaxial Information Technology Cabling
  - k. ISO/IEC IS 11801: Generic Cabling for Customer Premises
  - l. NECA/FOA 301-2016: Standard for Installing and Testing Fiber Optics
  - m. ANSI/BICSI N1-2019: Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
  - n. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the most recent edition of its related amendments for Gigabit Ethernet Standard
  - o. BICSI: BICSI Telecommunications Cabling Installation Manual (TCIM)
  - p. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)
  - q. BICSI: BICSI Outside Plant Design Reference Manual (OSPDRM)
  - r. BICSI: BICSI Network Design Reference Manual (NDRM)
3. Firestopping:
- a. ASTM E 84, “Surface Burning Characteristics of Building Materials”
  - b. ASTM E 119, “Fire Tests of Building Construction and Materials”
  - c. ASTM E 814, “Fire Tests of Through Penetration Firestops”
  - d. ANSI/UL263, “Fire Tests of Building Construction and Materials”
  - e. ANSI/UL723, “Surface Burning Characteristics of Building Materials”
  - f. ANSI/UL1479, “Fire Tests of Through Penetration Firestops”
  - g. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
- B. In case of differences between building codes, state laws, local ordinances, utility company regulations, and the Contract Documents, the most stringent shall govern; this shall not be construed as relieving the contractor from complying with any requirements of the plans or specifications which may be in excess of code requirements and not contrary to same.

## 1.5 DEFINITIONS

- A. “SCS” shall mean Structured Cabling System. The SCS is defined as all required equipment and materials including (but not limited to) ANSI/TIA/EIA 568-E and ISO/IEC 11801 compliant copper station cable (Category 6, Category 6A, etc.) and fiber optic cables, patch cables, stations and station connectors, termination blocks, patch panels, racks/enclosures (such as EIA standard equipment racks, enclosures, and vertical and horizontal cable management hardware), pathway/raceway materials (such as conduit, sleeves, D-rings, surface raceway, ladder rack, cable tray, etc.), and other incidental and miscellaneous equipment and materials as required for a fully operational, tested, certified, and warranted system, compliant with all applicable codes and standards.
- B. “UTP” shall mean Unshielded Twisted Pair cable.

- C. "TMGB" shall mean Telecommunications Main Grounding Busbar. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
- D. "TGB" shall mean Telecommunications Grounding Busbar. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.
- E. "TBB" shall mean Telecommunications Bonding Backbone. The TBB is a conductor used to connect TMGBs to TGBs.
- F. "EMT" shall mean Electrical Metallic Tubing.
- G. "RMC" shall mean Rigid Metal Conduit.
- H. "Raceway" shall mean any enclosed channel for routing wire, cable or busbars.
- I. "Pullbox" shall mean a metallic box with a removable cover, used to facilitate pulling cable through conduit runs longer than 100' or in which there are more than 180 degrees of bends.
- J. "Junction box" shall mean a pullbox wherein a feeder conduit transitions to multiple distribution conduits.
- K. "Wire gutter" shall mean a metallic raceway with a square cross-section used for routing wire or cabling.

## 1.6 REQUIREMENTS OF REGULATORY AGENCIES

- A. The entire installation shall comply with the code requirements of all authorities having jurisdiction.
- B. Contractor shall arrange for all inspections and shall correct non-complying installations.

## 1.7 PERMITS AND FEES

- A. The Contractor, at its expense, shall obtain permits and inspections required for the electrical work on this project. Inspection certificates shall be included in the Operation and Maintenance Manuals. Deliver copies thereof to the Architect/Engineer prior to final acceptance of the work.

## 1.8 SUBMITTAL INFORMATION

- A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.
  - 1. Submit a cover letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items and agrees that they are applicable to this

- project in all respects.
2. If (in the Contractor's judgment) the system as designed will not meet the required performance specifications, submit a detailed written description of the reasons.
  3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
  4. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit a written description detailing the reason for the substitution, along with standard manufacturer's cut sheets or other descriptive information.
  5. Submit a list of proposed test equipment for use in verifying the installation of the SCS. Proposed test equipment shall meet the criteria as stated in PART 3 – TESTING.
    - a. Submit for each testing device:
      - 1) Manufacturer and product number.
      - 2) Documentation from the manufacturer showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer's recommended calibration period, encompassing the period of time when the testing device will be used on this project.
      - 3) Documentation from the manufacturer showing software revision. Software revision shall be most current revision available for the device and shall be based upon the most current ANSI/TIA/EIA testing guidelines.
    - b. Submit proposed copper and fiber cable test forms (see PART 3 – TESTING for more detail).

B. Quality Control Submittals: Provide submittal information for review as follows:

1. Prior to bidding, in accordance with the QUALITY ASSURANCE requirements below, submit the following contractor-qualifications documentation:
  - a. Documentation from the SCS manufacturers demonstrating that the Contractor is trained and certified by the Manufacturers to install, test, and maintain the SCS and is certified by the SCS Manufacturers to provide the SCS Manufacturer's Warranty (see PART 1 - WARRANTY).
    - 1) For Copper:
      - (a) CommScope PartnerPro Uniprise Certified Installer
    - 2) For Fiber:
      - (a) Corning Network of Preferred Installers (NPI) Contractor
  - b. Documentation indicating that the Contractor will have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below.
    - 1) A list of the personnel who will be assigned to the project, the type of work they will be performing, and copies of the manufacturers' training certifications for each. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.
  - c. Documentation demonstrating that the Contractor employs a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The document shall declare that the RCDD is a direct full-time employee of the Contractor, and also that the Contractor will continue to employ a minimum of one RCDD throughout the duration of the project.
  - d. List of references for no less than five similar projects (in terms of size and construction cost) performed by the Contractor under the Contractor's current

business name within the past three years. Detail the following for each project:

- 1) Project name and location
- 2) Construction cost
- 3) A brief description of the project, the components involved, and the SCS manufacturer used on the project.
- 4) Number of station drops
- 5) Customer contact names, phone numbers, and addresses

C. Closeout Submittals: Provide submittal information for review as follows:

1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Engineer in the telecommunications-specific O&M Manual for Communications. Provide one electronic copy (PDF) of the O&M Manual for Communications.
2. Records - Maintain at the job site a minimum of one set of As-Built Drawings, Specifications, and Addenda. As-Built Drawings shall consist of redline markups of changes to Contract Documents such as drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
  - a. At the beginning of the work, set aside one complete set of the drawings to be maintained as a complete As-Built Drawings set. Notations shall be done in a neat and legible manner as specified in Division 01 and in accordance with the Architect/Engineer's instructions.
  - b. The As-Built Drawings shall be updated daily by the foreman to show every change from the original drawings, and the exact locations, sizes and kinds of equipment. Clearly identify system component labels and identifiers on As-Built Drawings. This set of drawings shall not be used for any other purpose and shall be maintained at the job site.
  - c. The actual locations and elevations of all buried lines, boxes, monuments, stub-outs and other provisions for future connection shall be shown on the As-Built Drawings, and shall be referenced to the building lines or approved benchmarks.
  - d. Keep As-Built Drawings at the job site and make them available to the Owner and Engineer at any time.
  - e. Keep As-Built Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction.)
  - f. Show identifiers for major infrastructure components on As-Built Drawings.
  - g. Upon completion of the job, deliver the marked-up As-Built Drawings to the Architect/Engineer.
  - h. Deliver As-Built in PDF format to the university's CCIT Point of Contact.

## 1.9 QUALITY ASSURANCE

A. All Division 27 Contractors:

1. Contractor's employees whose duties include the application of firestopping material shall be trained and certified by the specified firestopping manufacturer. Training and certifications by employee type are required as shown below:
  - a. Supervisors/Project Foremen: All (100%) shall be trained/certified for installation.
  - b. Firestopping Technician: All (100%) shall be trained/certified for installation.

B. Telecommunications Contractor Qualifications:

1. Contractor shall be trained and certified by the Manufacturers to install, test, and maintain the SCS and be certified by the SCS Manufacturers to provide the SCS Manufacturers' Warranties (see PART 1 - WARRANTY).
  - a. For Copper:
    - 1) CommScope PartnerPro Uniprise Certified Installer
  - b. For Fiber:
    - 1) Corning Network of Preferred Installers (NPI) Contractor
2. Contractor's employees directly involved with the supervision, installation, testing, and certification of the SCS shall be trained and certified by the selected SCS manufacturers. Training and certifications by employee type are required as shown below:
  - a. Supervisors/Project Foremen: Shall be trained/certified by the manufacturer for installation and testing.
  - b. Lead Technician: Shall be trained/certified by the manufacturer for installation and testing.
  - c. Other Technicians: All other technicians shall be trained by a manufacturer-trained employee, at no cost to the Owner.
  - d. Other personnel: Personnel not directly responsible for installation supervision, installation, testing or certifying the SCS (i.e. project managers, cleanup crew, etc.) are not required to be manufacturer trained and certified. Otherwise, untrained personnel shall not be allowed on the job site.
3. Contractor shall employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The RCDD shall be a direct full-time employee of the Contractor (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable). Contractor shall continue to employ a minimum of one RCDD throughout the duration of the project.
4. Contractor shall have successfully completed no less than five similar projects (in terms of size and construction cost) under the Contractor's current business name within the past three years.
5. Firms desiring to have their qualifications reviewed pursuant to a determination of their qualifications shall submit documentation of the above requirements not later than ten days prior to the bid opening. Firms that have not been evaluated for qualification shall not bid. The following firms have been pre-qualified:
  - a. none

#### 1.10 COORDINATION

- A. The Division 27 Contractor shall coordinate his work with that of the other contractors doing work in the building and shall examine all drawings, including the several divisions of mechanical, ventilating, structural and general, for construction details and necessary coordination.
- B. Coordinate and schedule connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- C. Coordinate the interruption of electrical systems to any part of the facility in use by the Owner at least 72 hours before interruption of the system.
- D. Special attention is warranted concerning the following items. All conflicts shall be reported to the Architect/Engineer before installation for decision or correction:



1. Location of fixtures, pipes, ducts and other mechanical equipment such that telecommunications and audio/visual outlets, wall-mounted telephone devices, equipment racks and panels, and other electrical equipment are mounted in proper relationship to these items.
  2. Location of cabinets and counters such that communications work is clear of and in proper relation to these items.
  3. Penetrations of building structure for communications work.
  4. Compliance to Section 110-26 of NEC.
  5. Coordination and provisions for maintaining telephone service to areas in use during construction, especially elevator equipment, fire alarm systems, security systems and emergency systems (comply with General Division Provisions).
  6. Communications equipment shall fit in the space provided on the plan drawings or as specified. Equipment heights shall not exceed those shown or specified. Larger equipment shall not be acceptable. Contractor shall be responsible for all clearances around the communications equipment.
- E. When conduit, inserts or sleeves for outlet boxes and/or conduits are required, Contractor shall fully coordinate the installation thereof with other trades.
- F. The communications contractor shall take full responsibility for furnishing, installing and troubleshooting all communications systems in the building. The communications contractor shall be responsible for overall coordination of all communications systems and ensuring correct and full operation of all systems and system interfaces. The communications contractor shall coordinate the interfaces between the communications systems and all other systems.

#### 1.11 SEQUENCING

- A. Provide coordination with the cabling manufacturers to ensure that manufacturers' inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any manufacturer-required modifications and have manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.
- B. The Contractor is solely responsible for all costs associated with scheduling the manufacturer inspection, the inspection itself and any manufacturer-required re-inspections, and for any modifications to the installation as required by the manufacturers.

#### 1.12 WARRANTY

A. Contractor Warranty:

1. Provide a Contractor-endorsed one-year service warranty against defects in materials and workmanship.
  - a. Provide all labor attributable to the fulfillment of this warranty at no additional cost to the Owner.
    - 1) The Contractor Warranty period shall commence upon Owner acceptance of the work.
  - b. This warranty shall not be voided by Owner's move, add and change activities. The resulting parts of any Owner-performed moves, adds and changes do not become part of the warranty. Nothing in this section shall be construed to terminate the warranty by performance of normal maintenance or service on the system or by expanding the

system in any manner consistent with the original design and intent for the system.

B. SCS Manufacturer Warranties:

1. Provide SCS Manufacturer extended product, performance, application, and labor warranties that shall warrant all passive components used in the SCS. Additionally, these warranties shall cover components not manufactured by the SCS Manufacturers, but approved by the SCS Manufacturers for use in the SCS (i.e. "Approved Alternative Products"). The SCS Manufacturer warranties shall warrant:
  - a. That the products will be free from manufacturing defects in materials and workmanship.
  - b. That the cabling products of the installed system shall exceed the specification of ANSI/TIA/EIA 568-E and exceed ISO/IEC 11801 standards.
  - c. That the installation shall exceed the specification of ANSI/TIA/EIA 568-E and exceed ISO/IEC 11801 standards.
  - d. That the system shall be application-independent and shall support both current and future applications that use the ANSI/TIA/EIA 568-E and ISO/IEC 11801 component and link/channel specifications for cabling.
2. Provide materials and labor attributable to the fulfillment of this warranty at no cost to the Owner.
3. The SCS Manufacturer Warranties shall be provided by the selected SCS Manufacturers and shall be:
  - a. For Copper:
    - 1) CommScope Network Infrastructure System 25-year Extended Product Warranty and Application Assurance System Warranty
  - b. For Fiber:
    - 1) Corning 25-year System Warranty
4. The SCS Manufacturer Warranty period shall commence upon a Warranty Certificate being issued by the manufacturer. The Warranty Certificates shall be issued no later than three months after Owner acceptance of the work.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Products and materials shall be as specified in the pertinent Sections of Division 27. Provide materials as specified. Equivalent materials are not acceptable unless specifically stated as "or equal," "or approved equal," "or pre-approved equal." Substitutions for some materials require the Owner's approval prior to bidding.
- B. Wherever possible, all materials and equipment used in the installation of this work shall be of the same Manufacturer throughout for each class of material or equipment. Materials shall be new and bear UL label. Comply with ANSI, IEEE and NEMA standards, where applicable.
- C. Components shall be manufactured by the manufacturers listed in Division 27. Components shall not be intermixed between different manufacturers unless the manufacturer has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the Manufacturer Warranty.
  1. Bid only the manufacturers for which the Contractor is certified.

- D. All copper-related components shall be part of the copper SCS product line and all fiber optic-related components shall be part of the fiber optic SCS product line – components shall not be intermixed between manufacturers’ SCS product lines. The SCS product lines shall be engineered “end-to-end” –
  - 1. the system and all of its components shall be engineered to function together as a single, continuous transmission path.
- E. Physically verify existing site conditions prior to purchase and delivery of the materials, including but not limited to lengths of conduit and/or pathway to be used for routing backbone cabling. Pre-cut materials of insufficient length are the sole responsibility of the Contractor.
- F. Provide materials, devices, equipment or supplies of materials that are inherently non-corrosive or are coated or covered in a manner, acceptable to the Engineer, which renders them non-corrosive. Material that may cause rusting or streaking on a building surface shall not be used.
- G. Provide all incidental and/or miscellaneous hardware (including equipment cables and connectors) not explicitly specified or shown on the Contract Documents that is required for a fully operational, tested, certified and warranted system.
- H. Provide cables of the same type or application in the same color throughout the project, unless otherwise indicated. Multiple colors of the same cable type are not acceptable.

## 2.2 TOUCH-UP PAINT

- A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.
- B. For Non-equipment Surfaces: Matching type and color of undamaged, existing adjacent finish.
- C. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

## 2.3 FIRESTOPPING

- A. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.  
Manufactured by:
  - 1. Specified Tech. Inc., Hilti, or approved equal, regardless of the products or manufacturers specified in Division 7.
- B. Fire-Rated Cable Pathways: Device modules shall be comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill:
  - 1. Specified Technologies Inc. (STI) EZ-PATH Fire Rated Pathway
  - 2. Hilti CFS-SL SK Firestop Sleeve Kit
- C. Firestop Pillows: Pillows shall be re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame-retardant poly bag:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows
2. Hilti CP 657 Firestop Brick

## 2.4 GROUNDING AND BONDING

- A. As specified under Division 27 Section — "Grounding and Bonding for Communications Systems."

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA and WISHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Equipment Dimensions and Clearances:
  1. Dimensions indicated for communications equipment and dimensions indicated for the installation of communications equipment are restrictive dimensions. Verify that equipment will fit within the indicated locations and spaces. Do not use equipment that impinges upon the required clearance, reduces actual clearance, or exceeds the indicated dimensions:
    - a. Except as approved in writing by the Engineer.
  2. Do not use arrangements of equipment that impinge upon the required clearance, reduce actual clearances or exceed the space allocation.
- F. Equipment Access:
  1. Install equipment so it is readily accessible for operation and maintenance.
  2. Access to equipment shall not be blocked or concealed by conduits, supporting devices, boxes, or other items.
  3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.
- G. Equipment shall be installed plumb, square and true with the building construction and shall be securely fastened.

- H. Do not provide materials which contain polychlorinated biphenyls, asbestos or other hazardous or detrimental materials. Do not install materials in a manner, location or construction that produces galvanic action or any other materials corroding or eroding action. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete. Outdoor wall-mounted equipment and indoor equipment mounted walls in contact with earth or water shall be provided with corrosion-resistant spacers to maintain ¼ inch separation between the equipment and the wall. Screen or seal all raceways or other openings into equipment to prevent the entrance of moisture, rodents and insects.
- I. Drawings indicate the approximate location and arrangement of electrical equipment and the approximate location of other equipment requiring electrical work. The general arrangement of panelboards, outlets and other equipment is diagrammatic and approximate as to locations. To avoid interference with structural members and equipment of other trades, it may be necessary to adjust the intended location of electrical equipment. Where minor changes are required because of structural or finish conditions or for the convenience of the Owner, provide such changes without additional expense to the Owner. Unless specifically dimensioned or detailed, the Contractor may, at his discretion, make
  - 1. minor adjustments in equipment location without obtaining the Engineer's approval. Minor adjustments are defined as a distance not to exceed:
    - 2. 1 ft at grade, floor and roof level in any direction in the horizontal plane.
    - 3. 1 ft for equipment at ceiling level in any direction in the horizontal plane.
    - 4. 1 ft on walls in a horizontal direction within the vertical plane.
  - 5. Changes in equipment location exceeding those defined above require the Engineer's approval.
  - 6. Particular attention shall be paid to door swings, piping, radiation, ductwork, and structural steel:
    - a. In general, waste and vent lines and large pipe mains and ductwork shall be given priority for the locations and space shown.
    - b. No additional compensation will be allowed for the moving of misplaced outlets, wiring, or equipment.
- J. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- K. Remove surplus material and debris from the job site and dispose of legally.

### 3.2 SCHEDULE

- A. Provide a time-scaled construction schedule indicating construction phases and deadlines associated with this work. At a minimum, the following tasks shall be shown on the schedule:
  - 1. Start of outside plant ductbank and maintenance hole construction
  - 2. Dates of outside plant ductbank concealment (concrete and backfill)
  - 3. Start of conduit and box rough-in
  - 4. Start of main campus cable feed to building MDF
  - 5. Start of MDF and IDF build out
  - 6. Start of vertical riser cable installation
  - 7. Start of horizontal cable installation

8. Start of horizontal cable termination
9. Date when elevator telephone service required
10. Date when fire alarm control panel fiber optic loop connection required
11. Date when building automation system (HVAC) will require network service
12. Date when access control / security systems will require network service
13. Start of outlet device termination and labeling
14. Start of installation testing – provide IT w/preliminary test results.
15. Start of final inspection process

### 3.3 INSTALLATION

- A. Install the equipment and materials in a neat and workmanlike manner employing workmen skilled in the particular trade and in accordance with the manufacturer's instructions and industry standards. Maintain adequate supervision of the work by a person in charge at the site during any time that work under this division is in process or when necessary for coordination with other work.
- B. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated. Mount enclosures for individual units at fifty-four inches above floors to centerline of controls.
- C. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated. All items shall be securely fastened.
- D. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- E. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Attach enclosures with a minimum of three fasteners, and more if the manufacturer so recommends.
  1. Attach enclosures mounted on equipment with machine screws or clamps as required. Do not drill equipment frames or sheets without permission of supplier/manufacturer or the Engineer.
  2. Stand equipment off wall surfaces a minimum of one-quarter inch where enclosures are mounted on walls in wet areas (outdoors, below grades, etc.) with neoprene, fiberglass or plastic shim washers.
  3. Welding to steel structure may be used only for threaded studs - not for conduits, pipe straps, or any other items.
- F. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.
- G. Give right of way to raceways and piping systems installed at a required slope.
- H. Make all penetrations of electrical work through walls and roofs water-tight and weather-tight.
- I. Install concrete pads and bases according to requirements of Division 03 Section "Cast-in-Place Concrete."

### 3.4 DEMOLITION

- A. Salvage to Owner existing telecommunications equipment, cable, materials, and incidentals no longer in use that are identified for salvage.
  - 1. Carefully remove all noted equipment such that it remains in a reusable condition while minimizing cosmetic scarring during salvage process.
  - 2. Deliver salvaged materials to the on-campus location indicated by the Owner's IT Representative. Coordinate a delivery time that is convenient for the Owner.
  - 3. After the salvage process has been completed, continue with demolition and restoration as described below.
- B. Demolish existing telecommunications equipment, cable, materials, and incidentals no longer in use after installation of and cutover to the new SCS. Demolish all existing devices and cables which are noted for demolition. Demolition includes, but is not limited to:
  - 1. Remove all conduit, conductors, fittings, device boxes, hangers, panels, devices, etc., which are not concealed in the building structure or below grade/slab.
  - 2. Remove existing conductors from conduits, unless otherwise indicated, where existing work is to be abandoned in place. Cut and remove buried raceway indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
  - 3. Do not remove or damage fireproofing materials. Repair or replace fireproofing that was removed or becomes damaged.
- C. When demolishing existing surface plastic/metal raceway, patch and/or paint wall to match existing undisturbed wall finish after raceway is removed.
- D. Locate, identify, and protect equipment and materials to remain. Where existing work to remain is damaged in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality at no additional cost to the Owner.
- E. Remove demolished material from the Project site and dispose of legally.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation and/or reconnection.
- G. Coordinate demolition activities with those pertaining to other Divisions.

### 3.5 SEISMIC REQUIREMENTS

- A. General: Electrical equipment for emergency systems shall be braced to withstand lateral forces that result from earthquakes. The Electrical Contractor shall provide seismic calculations stamped and signed by a registered Structural Engineer confirming size, number and location of all required anchoring hardware. Electrical equipment vendors shall submit weights, dimensions and center of gravity locations for all emergency electrical equipment for this purpose.

### 3.6 CUTTING AND PATCHING

- A. Cutting of Existing Structural Work: Holes in existing slabs and concrete walls shall be cored to the minimum size required. Contractor shall submit dimensioned drawings showing dimensioned sizes and locations for all holes to Architect/Engineer for approval before cutting. Where required for conduit installation, grade slabs shall be saw-cut to minimum required width. Approval drawings shall be submitted to Architect/Engineer before cutting.
- B. Patching: All holes or chases shall be patched to match adjacent surfaces.

### 3.7 PAINTING

- A. General: All finish painting of electrical equipment shall be as specified in Division 9, unless equipment is specified herein to be furnished with factory-applied finish coats. Equipment to be field-painted shall be supplied with factory-applied prime coat.
- B. Touch Up: If factory finish on any equipment furnished under this Division is damaged in shipment or during construction of the building, equipment shall be refinished by Contractor to the satisfaction of the Architect/Engineer.
- C. Concealed Equipment: All uncoated cast iron or steel that will be concealed or will not be accessible when installations are completed shall be given one heavy coat of black asphalt before installation.

### 3.8 CONCRETE WORK

- A. All concrete required for communications work shall be provided under Division 33.

### 3.9 FIRESTOPPING

- A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
- B. Maintain fire rating of penetrated fire barriers. Fire stop and seal penetrations made during construction.
  - 1. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
  - 2. Install firestops in strict accordance with manufacturer's detailed installation procedures.
  - 3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.
  - 4. For demolition work, apply firestopping to open penetrations in fire-rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable, or left empty after construction is complete.



5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
- C. Fire and smoke stopping sleeve devices shall be provided for all sleeve penetrations through fire-rated walls and wherever cables (not in conduit) pass through fire-rated walls. Devices shall be arranged singly or in gangs, and installed in strict accordance with the manufacturer's recommendations. Apply the factory-supplied gasketing material prior to the installation of the wall plates. Secure wall plates to devices per the equipment manufacturer's recommendations. Putty-type firestopping products are not acceptable.
- D. Fire and smoke stopping sleeve devices shall be provided for all floor-to-floor firestopping applications. Firestopping putty products shall not be used for vertically oriented applications.

### 3.10 GROUNDING AND BONDING

- A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, WAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
- B. Provide grounding and bonding as required under Division 27 Section — “Grounding and Bonding for Communications Systems” and as required under other Division 27 sections.

### 3.11 PROTECTION, CARE AND CLEANING

- A. Protection: Provide adequate protection for all finished parts of the materials and equipment against physical damage from any cause during the progress of work and until final completion. Sensitive electrical equipment shall not be installed until major construction is completed.
- B. Care: During construction, properly cap all lines and equipment to prevent the entrance of sand and dirt. Protect equipment against moisture, plaster, cement, paint or work of other trades by covering with polyethylene sheets.
- C. Cleaning: After installation has been completed, clean all systems as follows:
  1. Field Painted Items: Clean exterior of conduits, raceways, piping and equipment exposed in completed structure, removing rust, plaster, cement and dirt by wire brushing. Remove grease, oil and similar materials by wiping with clean rags and suitable solvents.
  2. Factory Finished Items: Remove grease, oil and dust on factory finished items such as cabinets, racks, and rack-mounted equipment, and leave surfaces clean and polished. Vacuum inside all electrical equipment and remove dust and debris.
- D. Connections: Prior to energizing, check all electrical connection hardware.

### 3.12 DAMAGE AND REPAIRS

- A. Emergency Repairs: Owner reserves the right to make temporary repairs as necessary to keep equipment in operating condition without voiding the Contractor's warranty or relieving the Contractor of his responsibility during the warranty period.

- B. Cabling that was intended to be protected from damage, but which has been damaged, shall be treated as follows:
  - 1. Fiber optic cabling shall be replaced in its entirety. Splicing to repair damaged fiber optic cabling is not acceptable, even if the Owner chooses temporarily to do so under an Emergency Repair as described above.
  - 2. Damaged copper cabling shall be replaced in its entirety.
  - 3. If the party responsible for the cabling damage is not listed in paragraph 1.9.B above as pre-qualified, the responsible party shall obtain the services of a pre-qualified contractor in that list to repair the damage at no cost to the Owner.
- C. Responsibility for Damage: Contractor shall be responsible for damage to the technology infrastructure, grounds, buildings, or equipment due to work furnished or installed under this Division.

### 3.13 SERVICE OUTAGES

- A. Any telephone or network service outage required to perform work under this Contract shall be performed at a time that is coordinated with and convenient to the Owner. Submit to the Owner (in writing) for Owner's approval, a schedule showing the dates and times the Contractor desires to perform outage-causing work. This schedule shall be submitted no less than five days prior to commencing work. It may be necessary to perform this work at night, on holidays or during maintenance shutdowns. The Contractor shall include in his bid all premium time labor costs for this work.

### 3.14 IDENTIFICATION AND LABELING

- A. General: Labeling and administration shall comply with ANSI/TIA/EIA 606 and standard industry practices.
- B. Labels shall be arranged such that they are readable after cabling has been dressed and secured.
- C. Labeling shall be affixed to all communications equipment, conduits, cabling and grounding/bonding systems as required in Division 27.

### 3.15 TESTING

- A. Test each cable in accordance with Contract requirements, manufacturer requirements, industry standards, and warranty requirements and as required in Division 27.
- B. Provide test records on a form approved by the Owner's IT Representative and Engineer. Submit the test results for each cable. The records shall include the unique cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner's IT Representative and Engineer for review and acceptance before project Substantial Completion date.
  - 1. Prepare and submit the test results in the native file type from the cable test device and also in Adobe Acrobat PDF electronic form (on a CDROM) to the Owner's IT

Representative and Engineer for review. Handwritten test results will not be accepted.

- C. Costs of test shall be borne by Contractor. Contractor shall provide all instruments, equipment, labor and materials to complete testing. Should tests detect any defective materials, poor workmanship or variance with requirements of Specifications, Contractor shall make any changes necessary and remedy any defects at his expense.

### 3.16 PRELIMINARY OPERATION

- A. The Owner reserves the right to operate portions of the communications system on a preliminary basis without voiding the warranty or relieving the Contractor of his responsibilities.

### 3.17 CLEAN-UP

- A. Upon completion and at other times during the progress of the work, when required, remove all surplus materials, rubbish and debris resulting from the work.

### 3.18 DEMONSTRATION

- A. Demonstrate equipment in accordance with Division 01.
- B. Provide assistance to the Engineer during the demonstration or observation of equipment by operating devices and equipment, opening enclosures for inspection, checking as-built drawing information, and similar tasks, as necessary in the Engineer's judgment, to verify all work performed.
- C. Acceptance is contingent on:
  - 1. Completion of final review and correction of all deficiencies.
  - 2. Satisfactory completion of acceptance tests which demonstrate compliance with all performance and technical requirements of Contract Documents.
  - 3. Satisfactory completion of training program and submission of all manuals and drawings required by Contract Documents.

### 3.19 OWNER-PROVIDED SERVICES

- A. The Owner will provide the following services:
  - 1. Connections to the Local Exchange Carrier, and Inter-exchange Carrier.
  - 2. Connections to the campus voice, video and data network.

END OF SECTION

## SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of a grounding and bonding system for inside plant telecommunications infrastructure. This section includes requirements for providing a permanent grounding and bonding infrastructure for horizontal and backbone communications circuits, equipment racking, raceways, and cable trays. These requirements are in addition to any that may exist in Section 26 – “Grounding.”

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Grounding and Bonding infrastructure for communications circuits, raceways, and cable trays as hereinafter specified and/or shown on the Contract Documents. The Grounding and Bonding system shall support a communications Structured Cabling System (SCS) that is NEC 250 compliant, ANSI/TIA/EIA compliant, and ISO/IEC compliant as specified in 27 11 00 – “Communications Equipment Room Fittings”. and 33 82 00 – “Communications Distribution.”
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working Grounding and Bonding system that is compliant with ANSI/TIA/EIA 607.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

#### 2.2 GROUNDING/BONDING

- A. Telecommunications Main Grounding Busbar (TMGB) shall be pre-drilled and sized approximately 20" x 4" x 1/4"
  - 1. Panduit GB4B0624TPI-1
  - 2. or approved equal
- B. Bonding Conductors
  - 1. #2 AWG bare copper conductor
- C. Compression Lugs shall have two bolt holes, be copper or tinned copper, with bolt-hole size and bolt-hole-spacing matching the size and spacing available in the grounding busbar, and be sized for the grounding/bonding cables that the lugs will be used to terminate

1. Panduit LCCX6-14A-L
2. or equal

## 2.3 LABELS

- A. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), industrial, permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
  1. Labels
    - a. Panduit Marker Tie
    - b. Brady B-422 Permanent Polyester (PN#MC1-1000-422)
    - c. or approved equal
  2. Hand-carried label maker:
    - a. Brady BMP41/51 Label Printer
    - b. or approved equal

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Install the grounding and bonding system in a manner ensuring that communications circuits, when installed, fully comply with the ANSI/TIA/EIA standards

### 3.2 INSTALLATION

- A. The grounding and bonding infrastructure system shall be bonded in accordance with NEC 250
  1. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure.

### 3.3 GROUNDING/BONDING

- A. TMGB: Provide a minimum of one TMGB per telecommunications room for each building and as shown on the Contract Documents. Install TMGB(s) and directly bond TMGB(s) to electrical service ground. Group protector, busbar bonding, and approved building grounding conductors toward the left end and leave space for equipment grounding conductors to the right end.
- B. Compression lugs shall be installed per the manufacturer's requirements and UL-listed terminating methods. Lugs shall be dual-crimped using the proper swaging tool. Conductors shall be inserted fully into the lugs, and both bolt holes shall be bolted using approved fasteners. Philips-head screws shall not be used to attach lugs.

### 3.4 LABELS

- A. Label TMGB(s) with “TMGB”. If the TMGBs are existing and unlabeled, provide labels for each. Minimum 1” Width. Black on white, thermal transfer.
- B. Label TGB(s) with “TGB”. If the TGBs are existing and unlabeled, provide labels for each. Minimum 1” Width. Black on white, thermal transfer.
- C. Label bonding conductors **“WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”** Black on white, thermal transfer.

END OF SECTION

## SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of hangers and supports for an inside plant telecommunication system.

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete system of hangers and supports for an inside plant telecommunications system as hereinafter specified and/or shown on the Contract Documents. The system shall support a communications Structured Cabling System (SCS) that is NEC compliant, ANSI/TIA/EIA compliant, and ISO/IEC compliant as specified in section 27 15 00 - Communications Horizontal Cabling.
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working Raceway system.

#### 1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide devices specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

#### 1.4 COORDINATION

- A. Coordinate layout and installation of devices with other construction elements to ensure adequate headroom, working clearance, and access.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Installation and materials for the raceway and boxes for the SCS shall be as specified under section 27 05 33 – “Conduits and Backboxes for Communications Systems” except where noted below.

#### 2.2 SLEEVES

- A. EMT conduit, with insulated throat bushings for each end.

## 2.3 CABLE SUPPORTS

- A. Cable Supports (J-Hooks, Straps) complete with incidental materials and assemblies required for mounting. CADDY, Monosystems and BLine products or approved equal:
  - 1. CADDY CableCat Wide Base Cable Supports (J-Hooks):
    - a. CAT12 (up to 16 4-pair/2-strand UTP/fiber cables)
    - b. CAT21 (up to 50 4-pair/2-strand UTP/fiber cables)
    - c. CAT32 (up to 80 4-pair/2-strand UTP/fiber cables)
    - d. CAT64 (up to 140 4-pair/2-strand UTP/fiber cables)
  - 2. CADDY CableCat Adjustable Cable Supports (Straps):
    - a. CAT425 (up to 425 4-pair/2-strand UTP/fiber cables)
  - 3. Monosystems steel, linkable, J-Hook System
    - a. The Hook (2"H X 3"W): H-233-S
    - b. The Hook (4"H X 3"W): H-433-S
    - c. Cable Support Extender: H-CSE-12

## PART 3 - EXECUTION

### 3.1 SLEEVES

- A. Consult with a registered Structural Engineer before penetrating concrete floors and concrete walls to prevent damage to structural features of the building.
- B. The Electrical Contractor shall provide seismic calculations stamped and signed by a registered Structural Engineer confirming size, number and location of all required anchoring hardware. Electrical equipment vendors shall submit weights, dimensions and center of gravity locations for all emergency electrical equipment for this purpose.
- C. Provide sleeves where required for cable pass-thru through building structures and/or fire rated barriers. Provide roto-hammering or core drilling where required for sleeve installation. Seal (and if a fire rated barrier, firestop) between sleeve and building structure and/or barrier.
- D. Size sleeves:
  - 1. As noted in the Contract Documents.
  - 2. Where not noted, size sleeves by the type and quantity of cable to be routed through the sleeve per ANSI/TIA/EIA 569 cable capacity standards plus an additional 50% for future expansion.

### 3.2 CABLE SUPPORTS

- A. Provide cable supports (J-Hooks, Straps) for routing cable in non-exposed open access environments as shown in the Contract Documents. Cable supports may be affixed to wall/ceiling structures or other supports, but shall not be attached to a ceiling support system.
  - 1. Where accessibility post-construction will be limited, provide conduit pathway instead of J-hooks to span the inaccessible section.



- B. Size supports according to the type and quantity of cable to be routed through the J-hook per ANSI/TIA/EIA 569 cable capacity standards, plus an additional 50% for future expansion.
- C. Mount cable supports at 5 foot or less intervals. Do not use cable supports for more cables than they were designed to support. Provide multiple cable supports where the total cable count exceeds the maximum cable count for which the support was designed.
- D. Cables shall not be supported directly by the building support structure.

END OF SECTION

## SECTION 27 05 33 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of a pathway system for inside plant communications circuits. This section includes requirements for horizontal and building backbone raceways, fittings, and boxes specific to communications circuits (cabling) for voice and data applications. These requirements are in addition to any that may exist in Section 26 – “Conduits and Backboxes.”

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Raceway system as hereinafter specified and/or shown on the Contract Documents. The Raceway system shall support a communications Structured Cabling System (SCS) that is NEC compliant, ANSI/TIA/EIA compliant, and ISO/IEC compliant as specified in 27 15 00 - Communications Horizontal Cabling.
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working Raceway system, compliant with ANSI/TIA 569.

#### 1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NECA's "Standard of Installation" and with NEC Quality Assurance.

#### 1.4 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Materials shall consist of conduit, surface metal raceway, outlet boxes, fittings, enclosures, pull boxes, and other raceway incidentals and accessories as required for inside plant communications circuits.

## 2.2 MATERIALS

### A. Conduit:

1. EMT: 1¼" trade size minimum, however 1" trade size may be permitted for some specifically- designated, limited applications.
  - a. Conduit: Galvanized steel tubing meeting ANSI C80.3.
  - b. Couplings: Steel couplings or malleable iron compression-type couplings employing a split, corrugated ring and tightening nut, with integral bushings and locknuts.
    - 1) Set-screw couplings are not permitted.
    - 2) Die-cast couplings are not permitted.
    - 3) Indent-type couplings are not permitted.
  - c. Insulated throat bushings: Arlington EMTxxx or equal.
  - d. Ground Wire Clamp: Penn-Union Zinc Die Cast Ground Clamp or equal.
2. RMC: 1¼" trade size minimum.
  - a. Conduit: Hot dipped galvanized steel with threaded ends meeting ANSI C80.1.
  - b. Couplings: Unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit.
  - c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.
  - d. Insulated throat bushings: Arlington RGDxxx or equal.
  - e. Ground Wire Clamp: Penn-Union Zinc Die Cast Ground Clamp or equal.
3. Flexible metal conduit (FMC) is not acceptable unless specifically indicated.

- B. Sleeves: EMT conduit, with insulated throat bushings for each end and ground wire clamp on one end.

### C. Condulets, Conduit Bodies and LBs

1. Typical electrical condulets, conduit bodies and LBs are prohibited without exception.
2. Special condulets, conduit bodies and LBs which are designed specifically for use with telecommunications cabling are permitted.
  - a. Madison Electric Smart LB, Die Cast Aluminum
    - 1) Trade Size 1¼ inch: KBLB120
    - 2) Trade Size 2¼ inch: KBLB250
    - 3) Trade Size 4 inch: KBLB400
  - b. or pre-approved equal

### D. Conduit Waterfalls: 4" trade-size.

1. Bejed BJ-2049 Cable Spillway
2. Panduit CWF400 Conduit Waterfall
3. or approved equal

- E. 5-Square Outlet Boxes: Minimum 5"x5" size, 2 7/8" minimum depth, with extension rings and reducing single gang covers (i.e. mud rings), unless otherwise noted on the Contract Documents. Combined interior depth of outlet box, extension ring and cover shall be a minimum 3 3/8". Welded steel, galvanized, with knockouts for 1¼" trade size conduit or connector entrance, meeting NEMA OS 1, with 4 cable management inserts.

1. Acceptable manufacturers for indoor applications:
  - a. RANDL Industries, Inc., T-series with cable management, available from the following sources:
    - 1) RANDL Industries, Inc. [www.randl-inc.com](http://www.randl-inc.com) (509) 340-0050.
      - (a) Outlet Box: T55017
      - (b) Reducing Ring: D-51G Series
    - 2) Thomas & Betts
    - 3) Siemon
- F. Outdoor Weatherproof Outlet Box applications:
  1. Single Gang:
    - a. Box: Taymac SB3100S with plugs for unused holes.
    - b. Cover: Taymac MX3200 with GFCI device configuration.
    - c. Or approved equal.
  2. Double Gang:
    - a. Box: Taymac DB5100 with plugs for unused holes.
    - b. Cover: Taymac MX6200 with GFCI device configuration.
    - c. Or approved equal.
- G. Surface Raceway and Boxes
  1. Acceptable manufacturers include:
    - a. Wiremold
    - b. Panduit
    - c. or pre-approved equal
- H. Outlet Box Support Brackets: Rough in brackets for mounting multiple device boxes in a single stud space.
  1. Acceptable manufacturers:
    - a. Brackets for 4-Square outlet boxes:
      - 1) BLine
      - 2) Thomas & Betts
      - 3) or equal
    - b. Brackets for 5-Square outlet boxes, RANDL Industries, Inc. [www.randl-inc.com](http://www.randl-inc.com) (509) 340- 0050:
      - 1) 16" Stud Spacing: RANDL 5BSB-16
      - 2) 24" Stud Spacing: RANDL 5BSB-24
- I. Floor Boxes:
  1. Legrand:
    - a. 6" poke-through device: Evolution 6AT series
    - b. Center Mount Device Plates: 6ACT8A
    - c. Side Compartment Device Plates: 682A
    - d. Cover Type: Surface, Flush
    - e. Cover Color: Black, Gray, Nickel, Bronze, Brass, Aluminum
  2. Legrand:
    - a. 8" poke-through device: Evolution 8AT series
    - b. Center Mount Device Plates: 8ACT6A
    - c. Side Compartment Device Plates: 682A

- d. Cover Type: Surface, Flush
    - e. Cover Color: Black, Gray, Nickel, Bronze, Brass, Aluminum
  - 3. FSR:
    - a. Box: FL-500P-x (where x = 6, 8 or 10 inches deep)
    - b. Cover: FL-500P-xxx-C
    - c. Slab-on-grade Pour Pan: FL-GRD2/4
    - d. Fire-rated Slab Pour Pan: FL-FRK-500P
  - 4. FSR:
    - a. Box: FL-600P-x (where x = 6, 8 or 10 inches deep)
    - b. Cover: FL-600P-xxx-C
    - c. Slab-on-grade Pour Pan: FL-GRD2/4
    - d. Fire-rated Slab Pour Pan: FL-FRK-605P
  - 5. Hubbell:
    - a. Recessed Multi-Service Concrete Floor Box: CFB7Gx (where x = 4 or 6 inch minimum depth of pour)
    - b. Cover: Aluminum, CFB7CVRALU
    - c. Cover: Brass, CFB7CVRBRS
  - 6. Hubbell
    - a. Box: LCFBSSA (6-gang, stamped steel)
    - b. Cover: Aluminum, LCFBCALT
    - c. Cover: Brass, LCFBCBRST
    - d. Cover: Black, LCFBCBKT
    - e. Cover: Gray, LCFBCGYT
  - 7. Steel City
    - a. Box: 668-S (4-gang, stamped steel)
    - b. Trim ring: 668
    - c. GFCI receptacle plates 668-S-1G
    - d. Cover: Aluminum powder coat, 668-CST-ALM
    - e. Cover: Brass powder coat, 668-CST-BRS
    - f. Cover: Black powder coat metallic, 668-CST-BLK
    - g. Cover: Brown powder coat metallic, 668-CST-BRN
    - h. Cover: Beige powder coat metallic, 668-CST-BGE
  - 8. Floor Boxes for in-floor wireless access points under fixed seating
    - a. 12" x 12" x 4" Box and Cover: CANTEX 5133714
    - b. 12" x 12" x 6" Box and Cover: CANTEX 5133713
- J. Junction Boxes and Pull Boxes: Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for conduit or connector entrance. Boxes 6"x6"x4" or larger may be code gauge fabricated steel continuously welded at seams and painted after fabrication.
- 1. Dry locations: meeting NEMA OS 1
  - 2. Wet locations: NEMA OS 3R
- K. Miscellaneous Fittings:
- 1. Die-cast fittings are prohibited.
  - 2. Locknuts and conduit bushings: Malleable iron
    - a. Appleton, Crouse Hinds, OZ Gedney, or equal
  - 3. Through wall seals and floor seals shall be:
    - a. OZ Gedney FS and WS series

- L. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.

## 2.3 LABELING AND ADMINISTRATION

- A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
  - 1. Labels:
    - a. Brady (or approved equal)
    - b. Hand-carried label maker: Brady (or approved equal)
    - c. Minimum 1" width. Black on white, thermal transfer.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Install the raceway system in a manner ensuring that communications circuits, when installed, fully comply with ANSI/TIA/EIA Standards.

### 3.2 EXAMINATION

- A. Examine surfaces and spaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not daisy-chain conduits and boxes unless specifically approved by the Engineer. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Notify the Engineer and the Owner's IT Representative of conditions that may adversely affect the installation or subsequent use to not comply with ANSI/TIA/EIA standards.

### 3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Conduit:
  - 1. Provide EMT unless other conduit shown on the Contract Documents is required by Code, or is permitted under these specifications.
  - 2. Provide RMC for outdoor applications and as shown on the Contract Documents, and where RMC is required by Code.
  - 3. Install conduit as a complete, continuous system without wires, mechanically secured and electrically connected to metal boxes, fittings and equipment. Blank off unused openings using factory-made knockout seals.
  - 4. Run conduit in the most direct route possible, parallel to building lines. Do not route conduit through areas in which flammable material may be stored.

5. Keep conduit at least 6 inches away from parallel runs of flues and steam or hot water pipes or other heat sources operating at temperatures above one hundred degrees Fahrenheit. Install horizontal conduit runs above water piping.
6. Keep conduit away from sources of electromagnetic interference as follows:
  - a. 5 inches from fluorescent lighting
  - b. 12 inches from conduit and cables used for electrical power distribution
  - c. 48 inches from motors or transformers
7. Do not exceed 90 meters total length for a given conduit run to be used for distribution cabling (from outlet box to telecommunications room), including intermediate conduits and junction boxes.
8. Install conduit exposed, except in finished areas or unless shown otherwise on the drawings. Do not install conduit below grade/slab unless specifically shown on the Contract Documents as being installed below grade/slab.
9. Install exposed conduit in lines parallel or perpendicular to building lines or structural members except where the structure is not level. Follow the surface contours as much as practical. Do not install crossovers or offsets that can be avoided by installing the conduit in a different sequence or a uniform line.
  - a. Run parallel or banked conduits together, on common supports where practical.
  - b. Make bends in parallel or banked runs from same centerline to make bends parallel.
10. Conduits concealed above ceilings, furred spaces, etc., which are normally inaccessible may be run at angles not parallel to the building lines.
11. Wherever practical, route conduit with adjacent ductwork or piping and support on common racks. Base required strength of racks, hangers, and anchors on combined weights of conduit and piping.
12. Where conduits cross building expansion joints, provide suitable sliding or offsetting expansion fittings. Unless specifically approved for bonding, provide a suitable bonding jumper.
13. Support conduits as specified in Section 27 05 00 "Common Work Results for Communications."
  - a. Provide anchors, hangers, supports, clamps, etc. to support the conduits from the structures in or on which they are installed. Do not space supports farther than five feet apart.
  - b. Provide sufficient clearance to allow conduit to be added to racks, hangers, etc. in the future.
  - c. Support conduit within three feet of each outlet box, junction box, gutter, panel, fitting, etc.
14. Ream conduits to eliminate sharp edges and terminate with metallic insulated grounded throat bushings. Close each conduit after installation (until cable is installed) with a removable mechanical-type closure to keep conduits clean, dry and prevent foreign matter from entering conduits.
15. For conduits entering through the floor of a telecommunications room, terminate conduits 4 inches above the finished floor, and no further than 4" from the wall, unless otherwise indicated.
16. Prior to installing communications conduits in wet, hazardous or corrosive locations, ensure that appropriate materials are used for the application.
17. Where conduit is shown embedded in masonry, embed conduit in the hollow core of the masonry. Horizontal runs in the joint between masonry units are not permitted.
18. Where conduit is shown embedded in concrete, embed conduit a minimum of two inches from the exterior of the concrete.
  - a. Do not place conduit in concrete less than five inches thick. Instead, route conduit beneath concrete.

- b. 1¼" trade size conduit shall be used. Conduits sized larger or smaller than 1¼" trade size conduit are not permitted embedded in concrete.
  - c. Run conduit parallel to main reinforcement.
  - d. Conduit crossovers in concrete are not permitted.
- 19. Where conduit exits from grade or concrete, provide a rigid steel elbow and adapter.
- 20. Where conduits terminate at a cable tray, the conduits shall be terminated no more than 8" from the cable tray, and have a visually uniform appearance. Do not provide an additional 90-degree sweep at the cable tray to redirect a horizontal conduit downward.
- 21. Where several conduits follow a common route, stagger pullboxes or fittings.
- 22. Bend and offset metal conduit with standard factory sweeps or conduit fittings. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
  - a. Conduit sweeps:
    - 1) Sweeps shall not exceed 90 degrees.
    - 2) Do not exceed 180 degrees for the sum total of conduit sweeps for a section of conduit (between conduit termination points).
    - 3) Sweep radius shall be at least 10 times the internal diameter of the conduit.
    - 4) 90-degree condulets (LBs) and electrical elbows are not acceptable.
  - b. Factory-manufactured sweeps are required for bends in conduit larger than 1¼" trade size.
  - c. For bends in 1¼" trade size conduit, field-manufactured bends (using a hydraulic bender with a 1¼" boot) are permitted only when factory-manufactured sweeps are not suitable for the conditions. In all other cases, factory-manufactured sweeps are required. "Hickey- bender" use is prohibited.
- 23. Connect conduit to hubless enclosures, cabinets and boxes with double locknuts and with insulating bushings. Use grounding bushings where connecting to concentric or eccentric knockouts. Connect conduits to enclosures at the nearest practicable point of entry to the enclosure area where the circuits contained in the conduit will terminate.
- 24. Penetrations for raceways:
  - a. Consult a licensed Structural Engineer prior to creating penetrations through building structural components. Identify the locations of structural steel concealed in concrete and prevent damage to the steel.
  - b. Do not bore holes in floor and ceiling joists outside center third of member depth or within two feet of bearing points. Holes shall be 1½" diameter maximum.
  - c. Penetrate finished walls and finished surfaces with a PVC or sheet metal sleeve with an interior diameter (ID) at least ¼" greater than the outer diameter (OD) of the conduit, set flush with walls, pack with fiberglass, seal with silicone sealant and cover with escutcheon plate.
  - d. Penetrate poured-in-place walls and free slabs with a cast iron sleeve (or Schedule 40 PVC black pipe sleeve for above-grade only) with retaining ring or washer. Set sleeves flush with forms or edges of slab. Pack around conduit with fiberglass and seal with silicone sealant.
- 25. Raceway terminations and connections:
  - a. Join conduits with fittings designed and approved for the purpose and make joints tight. Do not use set indent-type or die-cast couplings.
  - b. Make threaded connections waterproof and rustproof by applying a watertight, conductive thread compound. Clean threads of cutting oil before applying thread compound.
  - c. Make conduit terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  - d. Cut ends of conduit square using a hand saw, power saw or pipe cutter. Ream cut ends to remove burrs and sharp ends. Where conduit threads are cut in the field, cut threads to have same effective length, thread dimensions, and taper (pitch) as



- specified for factory- cut threads.
- e. Provide double locknuts and insulating bushings at conduit connections to boxes and cabinets. Align raceways to enter squarely, and install locknuts with dished part against
  - 1) the box. Use grounding type bushings where connecting to concentric or eccentric knockouts.
- f. Where conduits are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- 26. Install conduit sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - a. Where conduits pass from warm to cold locations, such as the boundaries of air-conditioned or refrigerated spaces and where conduits enter or exit buildings from outdoor areas, including underground ducts or conduit runs.
  - b. Where otherwise required by the NEC.
- 27. Prior to installing cabling, the following work shall be completed:
  - a. The electrician who installs a conduit shall install a pull string in each conduit.
  - b. The electrician who installs a conduit shall label the conduit as described below.
  - c. Insulated throat bushings, bonding lugs and bonding jumpers shall be installed.
  - d. Conduit shall be clean and dry.

C. Condulets, Conduit Bodies and LBs

- 1. Typical electrical condulets, conduit bodies and LBs are prohibited without exception.
- 2. Use special condulets, conduit bodies and LBs which are designed specifically for use with telecommunications cabling only where shown on the Contract Documents. Otherwise, use conduit sweeps.

D. Conduit Waterfalls

- 1. Provide conduit waterfalls at the ends of 4" conduits where noted on the Contract Documents and anywhere cabling elevation changes more than 12" as it exits or enters the conduit

E. Sleeves:

- 1. Provide sleeves where required, sized as noted on the Contract Documents. Where not noted, sleeve sizing shall be determined by the type and quantity of cable to be routed through the sleeve per TIA/EIA 569A cable capacity standards, plus an additional 50% for future expansion.
- 2. Provide roto-hammering or core drilling where required for installation.
- 3. Seal between sleeve and wall or floor in which the sleeve is installed. Firestop penetration to restore wall or floor to pre-penetration fire rating.

F. Wire Gutter:

- 1. Provide wire gutter as shown on Contract Documents.

2. Wire gutter shall be routed parallel to and perpendicular to surfaces or exposed structural members, and follow surface contours. Wire gutter shall not be warped during installation such that hinged cover operation is impaired.
3. Wire gutter color shall be painted according to Architectural requirements.
4. Wire gutter systems shall be completely installed, including insulating bushings and inserts as required by manufacturer's installation requirements. Unused openings in the surface raceway shall be closed using manufactured fittings.
5. Wire gutter covers shall open and close without obstruction and shall swing freely on hinges. Closure mechanisms shall securely retain the covers in their closed position.
6. Wire gutter shall be securely supported by screws or other anchor-type devices at intervals not exceeding 4 feet and with no less than six supports per straight section. Wire gutter shall be securely supported in accordance with the manufacturer's requirements. Tape and glue are not acceptable support methods.
7. Provide a continuous grounding conductor running the length of the wire gutter. Bond each section of wire gutter to the grounding conductor. Ensure that the grounding/bonding hardware breaks through painted surfaces and contacts bare metal.
8. For wire gutter installed in outdoor environments, seal all penetrations against moisture intrusion.

G. Outlet Boxes:

1. Provide outlet boxes and covers as shown on the Contract Documents and as needed. Verify that the appropriate cover type and depth is provided for each type of wall and finish. Provide extension rings as needed.
  - a. Provide a 5-Square by 2.875-Deep outlet box.
2. Each outlet box shall be provided with its own dedicated conduit. Do not daisy-chain boxes.
3. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.
4. Prior to installing communications boxes in wet, hazardous or corrosive locations, ensure that appropriate materials are used for the application.
5. Attach boxes securely to building structure with a minimum of two fasteners. Provide attachments to withstand a force of 50 pounds minimum, applied vertically or horizontally.
6. Install boxes at the following heights, except where noted otherwise:
  - a. Wall mounted telephones: 48 inches above finished floor to center line.
  - b. Workstation outlets: 18 inches above finished floor to center line.
  - c. Place boxes for outlets on cabinets, countertops, shelves, and similar boxes located above countertops two inches above the finished surface or two inches above the back splash. Verify size, style, and location with the supplier or installer of these items prior to outlet box installation.
7. Recessed mounted outlet boxes:
  - a. Recess boxes in the wall, floor, and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces within one-sixteenth inch for each condition. Set boxes so that box openings in building surfaces are within one-eighth inch of edge of material cut-out and fill tight to box with building materials. Single gang opening shall extend at least to the finished wall surface and extend not more than 1/8 inch beyond the finished wall surface. Provide backing for boxes using structural material to prevent rotation on studs or joists.
8. Surface-mounted outlet boxes (do not use except where specifically noted):
  - a. For boxes surface-mounted on finished walls, provide Wiremold/Panduit style outlet box. Cut box as necessary to accept conduit or surface raceway.

- b. For boxes surface-mounted on unfinished walls (i.e. electrical rooms, mechanical rooms), provide 5"x5" outlet box (depending on cable count) with double gang cover.
- 9. Outdoor outlet boxes:
  - a. For boxes mounted outdoors, provide weatherproof boxes and covers.

H. Floor Boxes and Poke-thru Devices:

- 1. Coordinate with requirements in Division 26. Verify that a minimum 1 ½" telecommunications conduit and electrical conduit are cooperatively installed to route telecommunications cabling to the box or poke-thru device.
- 2. Each floor box and poke-thru device shall be provided with its own dedicated conduit. Do not daisy-chain floor boxes or poke-thru devices.
- 3. Provide devices as shown on the Contract Documents.
- 4. Provide devices that are sized to support the applications designated for each box (electrical power, telecommunications, audio visual, etc.).
- 5. Provide mounting plates as required to support designated cable termination applications.
- 6. Provide designated covers, coordinated with interior decoration requirements.
- 7. Set devices plumb, level, square and flush with floor, within 1/16" tolerance for each condition.
- 8. For devices with both power and telecommunications circuits, provide metal dividers to separate power from telecommunications circuits.
- 9. For floor boxes intended for use with in-floor wireless access points under fixed seating:
  - a. Coordinate floor box location precisely to accommodate fixed seating. Floor boxes shall be located directly beneath a seat, between (avoiding) the legs of the seats and minimizing the opportunity for foot traffic to stand on the floor box.
  - b. Use either the 4" deep box or the 6" deep box to match the slab depth of the application and to match the telecommunications termination method (outlet or button jacks) that is intended to be mounted inside the box, in addition to the wireless access point that is approximately 9" x 9" x 2¼".
  - c. Each floor box shall be provided a dedicated conduit to the cable tray. Do not daisy-chain boxes. Conduit shall be 1½" trade size unless otherwise indicated. Cut hole in box for conduit entry and attach conduit to box.
  - d. Provide outlet with faceplate and jacks or button jacks solution as indicated in the Contract Documents.
- 10. Poke-thru Devices:
  - a. Provide poke-thru devices with appropriate jack mounting plates as required for each application. See Sections 27 15 00 and 27 41 00 for further information.
  - b. Coordinate with requirements in Division 26.

I. Junction Boxes:

- 1. Provide junction boxes as shown on the Contract Documents and as required.
  - a. Where sizing is not shown on the Contract Documents, size junction box length and depth according to the size of the feeder conduit in the following table:

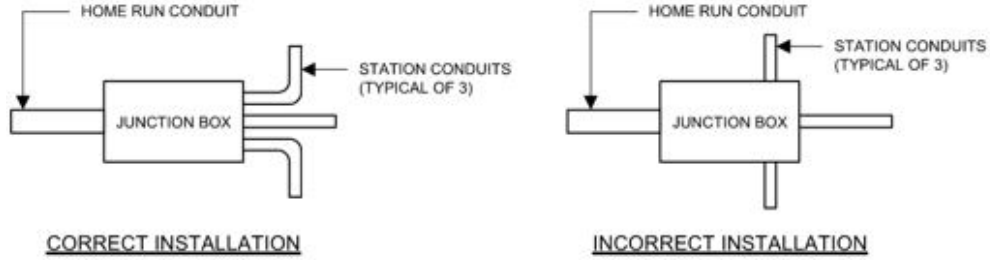
Feeder Conduit Size	Box Length	Box Depth
1"	12"	4"
1-¼"	12"	4"
1-½"	12"	4"
2"	24"	4"
2-½"	24"	6"

3	36"	6"
3-1/2"	48"	6"
4"	60"	6"

- b. Where sizing is not shown on the Contract Documents, size junction box width according to the following formula:
- 1) From the table below, select the width associated with the largest conduit on the distribution side of the box. For each additional distribution conduit, add the "Increase Width" value associated with the size of that distribution conduit to the box width for the largest distribution conduit.
    - (a) For example, if the distribution side of the junction box has three 1-1/4" distribution conduits and one 1" distribution conduit, the total distribution-side width would be 6"+3"+3"+2"=14".
  - 2) Repeat the above process for the feeder side of the junction box. Junction boxes are typically fed by a single conduit, therefore unless the box has more than one feeder conduit, the "Increase Width" part of the formula is unnecessary.
    - (a) For example, if the feeder side of the junction box has two 2" feeder conduits the total feeder-side width would be 8"+5"=13".
  - 3) The larger of the two width calculations (distribution side vs. feeder side) shall be the width of the junction box to be provided.
    - (a) For example, if the distribution-side width were 10" and the feeder-side width were 13", provide a 13" wide junction box.

Conduit Size	Box Width	For each additional conduit Increase Width
1"	4"	2"
1-1/4"	6"	3"
1-1/2"	8"	4"
2"	8"	5"
2-1/2"	10"	6"
3	12"	6"
3-1/2"	12"	6"
4"	15"	8"

2. A junction box may not be substituted for a 90-degree bend. 90 degree condulets (LBs) are not acceptable.
3. Install junction boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install junction boxes in inaccessible interstitial building spaces.
4. Where junction boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install junction boxes so that the access door opens from the side where the cable installer will normally work – typically from the bottom (floor side) of the box.
  - a. Where a junction box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
  - b. Provide a lockable access cover (or junction box door if junction box is exposed) in hard lid ceilings.
7. Install junction boxes such that conduits enter and exit at opposite ends of the box as follows:

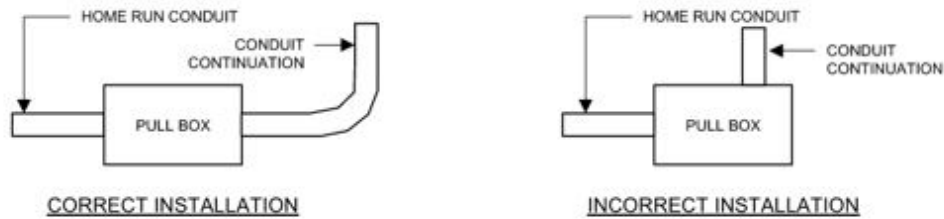


#### J. Pull Boxes:

1. Provide pull boxes as shown on the Contract Documents and as required.
  - a. Where sizing is not shown on the Contract Documents, size pull boxes as follows:

Size of Largest Conduit	Box Width	Box Length	Box Depth
1"	4"	12"	4"
1-1/4"	6"	12"	4"
1-1/2"	8"	12"	4"
2"	8"	24"	4"
2-1/2"	10"	24"	6"
3"	12"	36"	6"
3-1/2"	12"	48"	6"
4"	15"	60"	6"

- b. Where a pull box is required with conduits 1" trade size or smaller, an outlet box may be used as a pull box. Where outlet boxes are used as pull boxes, the outlet boxes shall be dedicated for use as a pull box and shall not host cable termination hardware.
2. A pull box may not be substituted for a 90-degree bend. 90 degree condulets (LBs) are not acceptable.
3. Install pull boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install pull boxes in inaccessible interstitial building space.
4. Where pull boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install pull boxes so that the access door opens from the side where the cable installer will normally work (typically from the bottom, or floor side, of the box).
  - a. Where a pull box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
  - b. Provide a lockable access cover (or pull box door if pull box is exposed) in hard lid ceilings.
7. Install pull boxes such that conduits enter and exit at opposite ends of the box as follows:



### 3.4 GROUNDING/BONDING:

- A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, UAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
  - a. Bond metallic raceway together and to the nearest TGB (as provided under Division 27 Section “Grounding and Bonding for Communications Systems”). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.
- B. Install bonding conductors between conduit and cable tray prior to the installation of cabling. Terminate the bonding conductor on the wall-side of the cable tray (not the corridor side) to avoid obstructing the installation of cabling.

### 3.5 LABELS:

- A. Conduits: Label each conduit end in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.
  - 1. Where a conduit is intended for future cabling use outside of the Contract, the conduit shall be labeled in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, etc.) along with a sequential number for each spare conduit terminated into a single room. Indicate conduit length on the label.
    - a. Suggestion: The second spare conduit (whether spare or in use) between Room 100 and telecommunications room 205 might be labeled in the telecommunications room as “Room 100 - #2, \_\_\_ feet.” In Room 100 the same conduit might be labeled “205 - #2, \_\_\_ feet.”
- B. Pull Boxes: Label each pullbox with a unique identifier. Identifiers shall be of the form “RN-Y” where “RN” is the room name/number of the room closest to (or containing) the pull box, and “Y” is the sequential number of the pull box for each “RN”.
  - 1. Example: The second pull box in room “100” would have the label “100-2”.

### 3.6 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, to ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to paint finishes with matching touchup paint recommended by manufacturer.

### 3.7 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION

## SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of a cable tray system for communications infrastructure. This section includes requirements for providing a cable tray system for communications circuits. These requirements are in addition to any that may exist in Division 26 – “Cable Tray.”
- B. See section 09 21 16 – “Gypsum Board Assemblies” for wall framing requirements associated with cable tray openings.

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Cable Tray infrastructure for communications circuits as hereinafter specified and/or shown on the Contract Documents. The Cable Tray system shall support a communications Structured Cabling System (SCS) that is NEC compliant, ANSI/TIA/EIA compliant, and ISO/IEC compliant as specified in Division 27 Section — “Communications Horizontal Cabling and in Division 27 Section — “Communications Backbone Cabling.”
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Cable Tray system.

#### 1.3 REFERENCES

- A. The applicable portions of the following specifications, standards, codes and regulations shall be incorporated by reference into this section:
  - 1. ASTM A123/A123M – Specification for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
  - 2. ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, Structural (Physical) Quality.
  - 3. ASTM A1011/A1011M – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low-Alloy with Improved Formability.
  - 4. ASTM A1008/A1008M – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low-Alloy with Improved Formability.
  - 5. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
  - 6. NEMA VE 1 – Metallic Cable Tray Systems
  - 7. NEMA VE 2 – Cable Tray Installation Guidelines.



## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, blind end plates, barrier strips, radius drops, bonding conductors and other incidentals and accessories as required. Provide all incidental and/or miscellaneous hardware not explicitly specified or shown on the Contract Documents that is required for a fully operational and warranted system.
- B. Unless specifically stated as "Or equal", equivalent items are not acceptable. Provide items as specified.
- C. Physically verify existing site conditions prior to purchase and delivery of the materials.
- D. Except for the use of ladder rack and wire basket tray where indicated, open bottom type cable trays, where cable and wiring are exposed to view are not acceptable.
- E. Structure of trays shall be suitable to support a continuous loading of cables weighing 75 lbs. per linear foot, when supported on 12' centers, without any deflection exceeding 1/100 of the span, with a safety factor of 1.50.
- F. Interior surfaces shall be smooth and free of offset edges, projections or misalignment. Assembly bolts for end-to-end connections shall have a pattern which does not cause damage to cable sheaths or jackets. All edges shall be smooth, rounded and de-burred.
- G. Manufacturer's factory-fabricated accessories and special transitions shall be provided for all changes in direction, elevation and offsets. Use manufacturer's standard fittings including bolting assemblies for all end-to-end connections.
  - 1. Field-fabricated transitions shall not be accepted.
- H. Spine-type cable tray is not permitted. Ladder racking shall be used only in telecommunications rooms.

### 2.2 WIRE BASKET (MESH) TRAY

- A. Wire mesh tray components shall be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.
  - 1. The cable tray manufacturer shall be one of the following:
    - a. MP Husky
    - b. Cablofil
    - c. GS Metals
    - d. PW
    - e. WBT
    - f. or pre-approved equal
  - 2. Substitution is not acceptable unless the cable tray manufacturer has been pre-approved prior to bidding. Contractors, in order to obtain approval for cable tray manufacturer

substitution, shall submit their request for substitution to the Engineer at least ten days prior to the bid date. Approval or denial of a substitution request will be based upon the judgment of the Engineer and the Owner's IT Representative.

- B. For a given manufacturer, all components shall be part of a single cable tray product line – components shall not be intermixed between a manufacturer's cable tray product lines.
  - 1. The cable tray product one shall be one of the following Electroplated Zinc galvanized product lines, 2" deep and 4" deep as the application requires:
    - a. MP Husky: TechTray BF2R-xxxx-EZ Series
    - b. Cablofil, Inc.: EZ Tray CF54/xxx and CF105/xxx Series
    - c. GS Metals: EG Flextray FT2 and FT4 Series
    - d. PW: Wire Mesh Cable Trays 8020 and 8040 Series
    - e. WBT: Shaped Wire Mesh Cable Trays WBT2xYY S ZP and WBT4xYY S ZP Series
- C. Wire mesh tray shall be constructed of welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Tray shall be complete with all supports, materials, and incidental and miscellaneous hardware required for a complete cable tray system.
  - 1. Finish: Carbon steel with electro-plated zinc galvanized finish.
  - 2. Width: Widths shall be as shown on the Contract Documents. Where cable tray width is not shown on the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown on the Contract Documents) plus an additional 50% for future expansion capability.
  - 3. Depth: Depths shall be as shown on the Contract Documents. Where cable tray depth is not shown on the Contract Documents, it shall be 4".
  - 4. Mesh: 2 x 4 inches.
  - 5. Fittings: Fittings shall be field-fabricated from straight sections using manufacturer-approved tools and in accordance with manufacturer's instructions.
- D. Cable tray shall be factory-galvanized and then painted onsite as indicated in the Contract Documents. Do not paint cabling.

## 2.3 SUPPORTS

- A. Cable tray supports shall be as shown on Contract Documents.
- B. Wall bracket supports, per manufacturer's requirements:
  - 1. Cable tray shall be attached to bracket.
  - 2. Brackets shall provide for open side access cable lay-in capability.
  - 3. Coordinate bracket installation with General Contractor for blocking and backing support for cable tray installation.
- C. Trapeze-style hanger supports, per manufacturer's requirements:
  - 1. Cable tray shall be attached to bracket, with threaded rod hangers placed outside the tray (not passing through the tray).
  - 2. Coordinate threaded-rod installation with General Contractor for blocking.
  - 3. Provide 10" of sleeving material (aluminum tubing or unmarked hard-plastic sleeving) around threaded rod at base of rod to protect cabling from damage due to rubbing on

threaded rod during installation.

D. Center hanger supports, per manufacturer's requirements:

1. Cable tray shall be attached to bracket.
2. Center support hangers shall provide for open side access cable lay-in capability.
3. Coordinate center hanger installation with General Contractor for blocking and backing support for installation of angled sway-prevention member.
4. Provide 10" of sleeving material (aluminum tubing or unmarked hard-plastic sleeving) around threaded rod at base of rod to protect cabling from damage due to rubbing on threaded rod during installation.

E. Single channel supports shall be formed finished steel shapes.

## 2.4 GROUNDING AND BONDING

A. Continuous Grounding Conductor: 6 AWG bare copper conductor. Using the cable tray or wire mesh tray as a grounding conductor, with bolted splicing hardware and bonding jumpers, is not acceptable. Grounding conductor shall run continuous (not spliced) throughout the length of the tray.

B. Grounding Lugs:

1. Wire Mesh Tray
  - a. MP Husky: Ground Clamp BGC-35
  - b. GS Metals: GROUNDBOLT with Ground Support Clip GROUNDSUPT GL
  - c. Cablofil: GNDCL Grounding Lug with GS Metals Ground Support Clip GROUNDSUPT GL
  - d. PW: 9992-A840-01 with attachment clamp 9999-1873-03
  - e. WBT: GROUND BOLT

C. Grounding Connectors:

1. Wire Mesh Tray
  - a. Panduit: E-Tap Grounding Connector GCE1/0-1/0
  - b. Approved equal

## 2.5 FIRESTOPPING MATERIAL

A. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.  
Manufactured by:

1. Specified Tech. Inc.

## 2.6 LABELING AND ADMINISTRATION

- A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
  - 1. Labels: Brady: (or approved equal)
  - 2. Label Clips: Manufactured by the cable tray manufacturer. If manufacturer does not provide label clips, use Cablofil.
  - 3. Hand-carried label maker: Brady: (or approved equal).

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Install the cable tray system in a manner ensuring that communications circuits, when installed, fully comply with the ANSI/TIA/EIA Standards.
- B. Electrical power circuits are not permitted to be routed in telecommunications cable trays.

### 3.2 EXAMINATION

- A. Examine surfaces and spaces to receive cable tray for compliance with installation tolerances and other conditions affecting performance of cable tray installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Notify the Engineer/Owner of conditions that may adversely affect the installation, subsequent use, or cause the tray (or circuits to be subsequently installed in the tray) to not comply with ANSI/TIA/EIA standards.

### 3.3 INSTALLATION

- A. Provide cable tray, in the locations and widths shown on the Contract Documents and in accordance with manufacturer's requirements and industry practices (NEMA VE 2). Ensure that the cable tray equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
  - 1. Cable tray shall be installed plumb, level and square with finished building surfaces.
  - 2. Cable tray shall be protected from damage prior to and during installation. Visible warping, dents, and other damage are prohibited. Remove and replace any damaged tray segments.
  - 3. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed according to the manufacturer's requirements.
  - 4. Cable tray elevation changes shall be gradual or as shown on the Contract Documents.

B. Wall Penetrations:

1. Provide wall penetrations where required and as shown on the Contract Documents. Provide roto-hammering, core drilling and saw cutting where required for installation.
2. Provide flanged, finished pass-through as shown on the Contract Documents.
3. Seal between slot/sleeve and cable tray.
4. If wall is a fire-rated barrier:
  - a. Provide firestopping between slot/sleeve and cable tray.
  - b. Provide fire-rated cable pathway hardware through wall.

C. Cable Tray Routing:

1. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.
2. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous or corrosive areas.
3. If construction circumstances require an adjusted routing that passes through a plenum air space in contrast with the original design through a non-plenum air space, the cable tray installer shall coordinate this change with the cabling installer and change the cabling to be plenum-rated.

D. Cable Tray Clearance Requirements:

1. Clearance requirements for cable tray accessibility:
  - a. Maintain a clearance of 10" between top of cable tray and ceiling structure or other equipment or raceway.
  - b. Maintain a clearance of 12" between at least one side of cable tray and nearby objects.
  - c. Maintain a clearance of 2" between bottom of cable tray support brackets and ceiling grid or other equipment or raceway.
2. Clearance requirements from sources of electromagnetic interference (EMI):
  - a. Maintain a clearance of 5" or more from fluorescent lighting.
  - b. Maintain a clearance of 12" or more from conduit and cables used for electrical power distribution.
  - c. Maintain a clearance of 48" or more from motors or transformers.
  - d. Pathways shall cross perpendicularly to electrical power cables or conduits.
3. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot water pipes or other heat sources operating at temperatures above one hundred degrees Fahrenheit.

E. Cable tray supports shall be provided where shown on the Contract Documents. Where not shown on the Contract Documents, supports shall be provided according to the manufacturer's recommendations.

1. Load span criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.
2. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
3. Where cable trays abut walls, provide wall-mounted supports.

4. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
  5. Except where specifically indicated, do not use center-hung as a cable tray support mechanism.
- F. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation or cause cuts to cable installation technicians.
1. Where burrs, sharp edges, or projections occur, remove sharp surfaces and repair coating.
- G. Cable tray shall be free of denting and other bending damage in surfaces that are intended to be straight and true.
- H. Wire mesh-type cable tray shall be cut with a manufacturer-approved cutter with “offset cutting blade” jaws and a minimum 24-inch handle.
1. The position of the jaws at the point where the cut is to be made shall allow shearing as close as possible to the intersection of the steel wires.
  2. Cuts shall ensure the integrity of the galvanic protective layer.
  3. Do not use saws to cut tray.
- I. Fittings and Accessories
1. Wire Mesh Tray Fittings:
    - a. Provide field-fabricated fittings from straight sections of cable tray using manufacturer- approved tools and in accordance with manufacturer’s instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically shown on the Contract Documents.
    - b. To the extent that factory-manufactured fittings and accessories are available from the wire basket manufacturer, provide factory-manufactured parts instead of using field-fabricated features.
- J. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where shown on the Contract Documents and where cable tray crosses building expansion joints. Provide bonding jumper except where expansion joints are specifically approved for bonding.
- K. Thermal contraction and expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and also during normal occupancy and operation.
- L. Blind End Plates: Close unused openings using factory-made blind end plates.
- M. Radius Drops: Provide cable tray radius drops where shown on the Contract Documents and where cable trays cross other telecommunications cable trays or ladder rack. Provide radius drops where corridor trays enter telecommunications rooms and where cabling transitions from a cable tray down to another raceway below the tray.

### 3.4 GROUNDING AND BONDING

- A. Bond metallic raceway (including cable tray) together and to the nearest TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems").

- B. Install bonding prior to priming and painting. Ensure that bonding breaks through the factory finish to establish contact with the metallic substrate.
- C. Provide a continuous (not spliced) bare (not insulated) bonding conductor running the length of the cable tray.
  - 1. Bond each tray segment to the conductor using listed hardware.
  - 2. Cable tray bonding jumpers/splices are not permitted as a substitute for a continuous grounding conductor.
- D. Bonding conductors:
  - 1. Bond distribution conduits and raceways to cable tray bonding conductor.
  - 2. Provide bonding jumpers at expansion joints, sleeves and any other locations where electrical continuity is interrupted.
  - 3. Provide bonding conductor between cable tray and the electrical power distribution system grounding infrastructure.

### 3.5 CLEANING AND PROTECTION

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris. Repair damaged finishes, including chips, scratches, and abrasions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

### 3.6 TESTING

- A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

### 3.7 LABELING AND ADMINISTRATION

- A. Provide the following label every 20 feet along the entire length of the cable tray:
  - 1. Label shall read "TELECOMMUNICATIONS / LOW VOLTAGE CABLING ONLY".
  - 2. Minimum 1" width. Black on white, thermal transfer.

END OF SECTION 270536

## SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of telecommunications cabinets, racks, frames, enclosures, cable management, and power hardware. This section includes hardware that supports the specified Structured Cabling System.
- B. Products installed (but not furnished) under this section:
  - 1. Grounding Conductor

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances associated with telecommunications cabinets, racks, frames, enclosures, cable management, and power hardware to support a communications Structured Cabling System (SCS) that is NEC compliant, ANSI/TIA/EIA compliant, and ISO/IEC compliant as shown on the Contract Documents.
- B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Structured Cabling System.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. See Section 06 10 00 "Rough Carpentry."
- B. Racks, rack cable distribution hardware, ladder rack, and other rack and distribution components shall be manufactured by a single manufacturer unless stated otherwise in this Specification or in the Contract Documents. Do not intermix equipment and components between different manufacturers.
  - 1. Rack/Distribution Equipment: Chatsworth Products, Inc. (CPI) or Cooper B-Line (B-Line)
  - 2. Ladder Racking Equipment: Chatsworth Products, Inc. (CPI) or Cooper B-Line (B-Line)

#### 2.2 CABLE SUPPORTS

- A. Backboards:
  - 1.  $\frac{3}{4}$  inch A-C grade, fire-retardant plywood backboards, void free, 8 feet high, unless otherwise noted.
  - 2. Primer
  - 3. White non-conductive paint, 2 coats.



B. D-Rings:

1. Metallic (CPI or equal):
  - a. Small (5 square inch Capacity): CPI 10941
  - b. Medium (10 square inch Capacity): CPI 10942
  - c. Large (16 square inch Capacity): CPI 10943

C. Ladder Rack: Complete with fittings including (but not limited to) splice kits, cable radius drop, radius bends, protective end caps, retaining posts, support brackets, foot kits, vertical wall brackets, wall angles, grounding hardware and other incidental and miscellaneous hardware required for a complete ladder rack system. Ladder rack components shall be manufactured by the selected Rack/Distribution Equipment manufacturer.

1. Unless otherwise indicated, all ladder rack and incidental equipment color shall be white.
2. Ladder rack:
  - a. Universal Cable Runway: CPI 10250-Exx (xx = width)
  - b. Or equal
3. Horizontal radius bends:
  - a. Cable Runway E-Bend: CPI 10822-Exx (xx = width)
  - b. Or equal
4. Cable Retaining Posts (8 inch-high):
  - a. CPI 10596-E08
  - b. Or equal
5. Radius Drops:
  - a. Stringer: CPI 12101-E01
  - b. Radius Drop: CPI 12100-Exx (xx = width)
  - c. Rung and Radius Drop Kit: B-Line SB17DRKxx
6. Triangle Support Wall-bracket for Cable runway:
  - a. CPI 11312-Exx (xx = width)
  - b. Or equal
7. Wall Angle Support bracket for Cable runway:
  - a. CPI 11421-Exx (xx = width)
  - b. Or equal
8. Vertical Wall Support bracket for Cable runway:
  - a. CPI 10608-E01
  - b. Or equal
9. Ladder rack/cable runway Grounding kits:
  - a. CPI 40164-001
  - b. Or equal
10. Ladder rack/cable runway Elevation kits:
  - a. CPI 10506-E06
  - b. Or equal
11. Ladder rack/cable runway end kits:
  - a. End Closing Kit:
    - 1) CPI 11700-Exx (xx = width)
    - 2) Or equal
  - b. End Caps:
    - 1) CPI 10642-001
    - 2) Or equal
12. Other factory-manufactured appurtenances as necessary.

## 2.3 EQUIPMENT RACKS/ENCLOSURES

- A. Unless otherwise indicated, equipment racks/enclosures and incidental equipment color shall be white.
- B. Unless otherwise indicated, equipment rack/enclosure/wall-mounted brackets and incidental materials and equipment shall be provided by the selected Rack/Distribution Equipment manufacturer. Do not intermix products from different manufacturers.
- C. Free Standing Equipment Racks: EIA-standard 7-foot high x 19-inch wide steel racks with universal alternating-hole pattern, complete with top angles, self-supporting bases, and mounting holes on both sides of the rails.
  - 1. Racks:
    - a. Standard Rack: CPI 46353-E03
    - b. Or approved equal
  - 2. Vertical Cable Management, double-sided, CPI-only:
    - a. 8" wide (for ends of row): CPI 35522-E03
      - 1) Cabling Spool Kit CPI 15008-001 (2 kits required for each 8" manager)
      - 2) Moveable Mid-Section CPI 35493-E02 (6 units required for each 8" manager)
      - 3) Spool Spacer Kit CPI 35505-001 (2 kits required for each 8" manager)
    - b. 10" wide (between racks): CPI 35523-E03
      - 1) Cabling Spool Kit CPI 15008-001 (1 additional kit required for each 10" manager)
      - 2) Moveable Mid-Section CPI 35493-E03 (3 additional units required for each 10" manager)
      - 3) Spool Spacer Kit CPI 35505-001 (2 kits required for each 10" manager)
    - c. 12" wide (between racks): CPI 35524-E03
      - 1) Cabling Spool Kit CPI 15008-001 (1 additional kit required for each 12" manager)
      - 2) Moveable Mid-Section CPI 35493-E04 (3 additional units required for each 12" manager)
      - 3) Spool Spacer Kit CPI 35505-001 (2 kits required for each 12" manager)
    - d. 4" wide single-sided, CPI-only (for A/C power): CPI 11730-E03
- D. Free Standing Equipment Cabinets: EIA 310-E Compliant.
  - 1. Cabinet, NEMA 1: Great Lakes GL840E-2936-CLU2
    - a. Doors shall be lockable and with mesh doors
  - 2. Cabinet, NEMA 12: Great Lakes GL840N12-3042-CLU3
    - a. Allows optional 2500-6000 BTU AC
- E. Rack and Cabinet Accessories
  - 1. Single sided low-profile equipment shelf
    - a. CPI 40074-700
    - b. B-Line SB747V1915SFB
  - 2. Double Sided equipment shelf:
    - a. Rack Solutions 3USHL-022FULL-29UV

F. Grounding kit and #6 AWG (insulated or bare) copper conductor grounded to the nearest TGB:

1. CPI 40164-001
2. B-Line SB6691x7<sup>3</sup>/<sub>4</sub>
3. or field-manufactured jumpers
4. Screws, washers and nuts that are UL rated for use with grounding and bonding and able to break through painted surfaces to the metal substrate.

G. Incidental materials required for proper construction, mounting and securing.

## 2.4 GROUNDING AND BONDING

A. As specified under Division 27 Section – “Grounding and Bonding for Communications Systems.”

## 2.5 LABELING AND ADMINISTRATION

A. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.

B. Labels:

1. Panduit Marker Tie
2. Brady adhesive nylon fabric thermal transfer label
3. Brady self-laminating vinyl thermal transfer label
4. Approved equal

C. Hand-carried label maker:

1. Brady BMP41/51 Label Printer
2. (or approved equal)

## PART 3 - EXECUTION

### 3.1 CABLE SUPPORTS

A. Backboards: Provide backboards as shown on Contract Documents. Backboards shall be capable of supporting attached equipment. Mount A-C plywood backboards with the “A” side exposed.

1. Paint backboards with a minimum of two coat (over primer) of non-conductive paint.
2. Mask the fire-treatment stamp on each sheet of plywood so that the stamp remains visible after painting.

B. D-Rings: Provide D-Rings as necessary to route exposed cables in telecommunications rooms and on backboards and for raceway for routing cable in non-exposed open access environments, and as shown in the Contract Documents. D-Rings may be affixed to wall/ceiling structures or

other supports, but not attached to a ceiling support system. In telecommunications rooms, mount D-Rings at 12-inch intervals and as shown in the Contract Documents.

1. Size D-Rings as noted in the Contract Documents.
  2. Where not noted, size D-Rings according to the type and quantity of cable to be routed through the ring per TIA/EIA 569 cable capacity standards, plus an additional 50% for future expansion, but not less than a minimum of 2 inches in diameter.
  3. D-Rings are not permitted outside of telecommunications rooms unless otherwise indicated in the Contract Documents.
- C. Ladder Rack: Provide ladder racking, sized and in locations as shown on the Contract Documents, installed per manufacturer's instructions with flat (rung) side up. Install ladder rack affixed to top of equipment racks to serve as equipment rack bracing.
1. Cut ends of ladder rack square. Ream cut ends to remove burrs and sharp edges. Cap cut ends with manufacturer's recommended caps.
  2. Provide 90-degree horizontal radius bends for each 90-degree change in direction of ladder rack angle.
  3. Provide cable runway grounding kits across ladder rack splices and where ladder racks are connected to equipment racks/cabinets.
  4. Provide cable retaining posts at each corner and junction, and wherever needed to manage cabling and innerduct, as follows:
    - a. The inside of ladder rack (away from wall), where rack is mounted adjacent to a wall.
    - b. Both sides of ladder rack where rack is not mounted adjacent to a wall.
  5. Where ladder rack is shown vertically mounted on telecommunications room walls, provide wall-mount brackets. Vertical ladder rack shall be routed from within 6-inches above the riser pathway in the floor up to within 6-inches of the riser pathway in the ceiling. Cap cut ends of ladder rails with end caps.

### 3.2 EQUIPMENT RACKS/ENCLOSURES

- A. Provide EIA racks/cabinets and all associated hardware according to locations, elevations, and plan views as shown in the Contract Documents.
- B. Free-standing Equipment Racks and Cabinets:
1. Bolt racks and cabinets to structurally suitable flooring.
  2. Ensure that designated power outlets are installed in the vertical cable management as designed. The telecommunications installer shall work with the electrician to coordinate the power conduit routing and outlet box locations to be cooperative and compatible with the rack and equipment layout.
  3. Attach top of rack to overhead ladder racking per manufacturer's recommendations. Use ladder rack elevation kits to span the gap between the top of the racks and the overhead ladder rack.

### 3.3 GROUNDING AND BONDING

- A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, UAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify

additional grounding and/or bonding requirements.

1. Provide a minimum of one wall-mountable telecommunications ground bus bar per telecommunications room and as shown on the Contract Documents.
2. Grounding conductor shall be installed to bond all non-current carrying metal telecommunications equipment and materials to the nearest TMGB or TGB (as provided under Division 27 Section — “Grounding and Bonding for Communications Systems”).
  - a. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
  - b. Provide ladder rack grounding kits to bond each section of ladder rack and bond ladder rack to racks/cabinets where ladder racks are connected.

### 3.4 LABELING AND ADMINISTRATION

- A. Telecommunications Rooms: Affix a permanent label with the telecommunications room number on the wall above the light switch inside each telecommunications room. Where telecommunications room names are required in other labels, use the room number assigned to the telecommunications room and as shown on the room signage as-constructed. Also include the telecommunications identification for the room on the label as indicated in the Construction Documents.
- B. Racks: Label racks in the form of “Floor Of TR, Compass Location, Rack #.” The sequential rack number given within a telecommunications room number left to right while facing the front of the racks. Affix label centered across top cross-member of rack.

END OF SECTION

## SECTION 27 13 00 - COMMUNICATIONS BACKBONE CABLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of an inside plant telecommunication system. This section includes Inside Plant Communications Backbone cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System (SCS - See Definition Below).

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete communications Structured Cabling System (SCS) that is compliant with ANSI/TIA/EIA, NECA/NEIS and ISO/IEC standards as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of 10 Gigabit Ethernet operation as specified in TIA/EIA 568.2-D, ISO/IEC 11801-1:2017 and ISO/IEC 11801-2:2017.
- B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. SCS components shall be manufactured by the manufacturers listed below. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the SCS Manufacturer Warranty (see PART 1 - WARRANTY).
  - 1. Bid only the following SCS Manufacturers, and only bid manufacturers for which the Contractor is certified. The SCS Manufacturers shall be the following. Substitution is not acceptable:
    - a. CommScope for copper backbone cable products with CommScope for copper backbone patch panels.
    - b. Corning for fiber optic-related products
      - 1) CommScope fiber optic cabling products are not acceptable.

#### 2.2 FIBER OPTIC PATCH PANELS

- A. Fiber Patch Panels: Pre-assembled enclosures with connector panels, blank connector panels (for unused connector panel slots), and strain relief, complete with fiber connectors and fiber optic receptacle adapters (see CONNECTORS below), and with incidental materials necessary

for mounting. Fiber patch panels shall be manufactured by the selected SCS Manufacturer:

1. Rack-mounted patch panels:
  - a. Corning CCH-02U (2U, 4 modules)
  - b. Corning CCH-03U (3U, 6 modules)
  - c. Corning CCH-04U (4U, 12 modules)
2. Wall-mounted patch panels:
  - a. Corning SPH-01P (1 connector panel) and DIN Rail Kit SPH-DIN-KIT
  - b. Corning WCH-02P (4 connector panels)
3. 12" Strain Relief Brackets: Corning CDF-RJ12-BKT
4. 12-strand MTP Universal Modules:
  - a. Singlemode Duplex LC UPC: Corning CCH-UM12-04-89 G
5. Connector Panels:
  - a. Singlemode (12-strand/6-connector):
    - 1) Duplex LC: Corning CCH-CP12-A9
    - 2) Duplex LC: Corning CCH-CS12-A9-P00RE

## 2.3 COPPER TERMINATIONS

- A. Copper Backbone Patch Panels: Complete with pre-manufactured cable management for supporting station cable behind the patch panel, and with incidental materials necessary for mounting. Shall exceed the Category 6A transmission performance requirements for connecting hardware, as specified in TIA/EIA 568.2-D, ISO/IEC 11801-1:2017 and ISO/IEC 11801-2:2017. Copper patch panels shall be manufactured by the selected SCS Manufacturer:

1. CommScope Category 6A
  - a. 24-Port: CommScope CPP-UDDM-SL-1U-24 (760237040)

## 2.4 INNERDUCT

- A. No required unless otherwise specified.

## 2.5 CABLE

- A. General: Cables shall be manufactured by the selected SCS Manufacturer.

B. Copper Cable:

1. Copper backbone cable shall be non-shielded solid copper conductors insulated with color-coded PVC, and UL Verified to TIA/EIA 568-D for Category 6A performance. Cable shall be manufactured by the selected SCS Manufacturer:
  - a. CommScope Cat 6A Series CS44
  - b. Plenum-rated or riser-rated as required
  - c. White Jacket

C. Fiber Cables:

1. Singlemode 8.3/125  $\mu$ m: Maximum attenuation of 0.4 dB/km @ 1300 nm and 0.3 dB/km @ 1550 nm. Cable shall be non-pinned and non-armored plenum or riser rated as required

by code. A pulling grip shall be provided for the pulling-end of the cable. Cable shall be manufactured by the selected SCS Manufacturer and shall be:

- a. Corning Plug & Play Universal Systems MTP Trunks: A 90 90 12 G PN B B xxx F with custom 30-character label printed on the cable in the form required in Part 3 Labeling and Administration, below.
- b. Corning MIC, 24 Strands
- c. Corning FREEDM Loose Tube Gel-Free, 24 Strands
  - 1) For open air plenums: Corning #024EWP-T4101D20
  - 2) For risers: Corning #024EUF-T4101D20

## 2.6 LABELING AND ADMINISTRATION

### A. Labels:

1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
  - a. For Backbone Cable:
    - 1) Panduit Marker Tie (or approved equal)

### B. Hand-carried label maker:

1. Brady: BMP41/51 (or approved equal).

## PART 3 - EXECUTION

### 3.1 PATCH PANELS

- A. Fiber Optic Patch Panels: Provide patch panels according to locations, elevations, and plan views as shown on the Contract Documents. Provide one 12" strain relief bracket for each patch panel.
  1. Size and install patch panels as shown on the Contract Documents. Use fiber patch panels to terminate backbone and horizontal fiber optic cables.
  2. Provide universal modules and connector panels as required and as indicated in the Contract Documents.
- B. Copper Backbone Patch Panels: Provide patch panels according to locations, elevations, and plan views as shown on the Contract Documents.
  1. Size and install patch panels as shown on the Contract Documents. Use copper backbone patch panels to terminate backbone copper cables.
  2. Provide lacing bars mounted on both front and back of patch panel.

### 3.2 INNERDUCT

- A. Not required unless specified.



### 3.3 CABLE

- A. General (applicable to all cable types): Provide non-plenum (CM/CMR, OFNR) rated cable for locations where cable is to be installed in conduit. For cable not installed in conduit, provide plenum (CMP, OFNP) rated cable if cable is installed in a plenum air space environment, otherwise install non-plenum rated cabling. Cabling shall bear plenum or non-plenum markings for the environment in which it is installed.
1. Provide intra-building backbone cable in types, sizes, and quantities as shown on the Contract Documents. Install intrabuilding backbone cables between telecommunications rooms within the same building. Provide cables of the same type in the same color – multiple colors of the same cable type are not acceptable.
  2. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
  3. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
    - a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.
    - b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
    - c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.
  4. Install cable in a continuous (non-spliced) manner unless otherwise indicated.
  5. Install exposed cable parallel and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
  6. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's installation recommendations. Do not over-tighten tie wraps or cause cross-sectional deformation of cabling.
  7. Cable at the backboards:
    - a. Lay and dress cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
    - b. Route cable as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
    - c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap similarly routed and similar cables together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.
  8. Cable in the telecommunications rooms:
    - a. For telecommunications rooms with ladder rack, lay cable neatly in lower level ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals with tie- wraps or hook-and-loop straps.
  9. Cable terminating on patch panels located on racks:

- a. Route cables in telecommunications rooms to patch panels on racks by routing across lower ladder rack across top of rack and then down vertical ladder rack to patch panel.
- B. Copper Cables: Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.
  1. Install intrabuilding backbone cable in the locations shown on the Contract Documents. Provide a service loop long enough in the telecommunications room to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum length of 10 feet at each end.
- C. Fiber Cables:
  1. Field-measure the required cable length prior to materials procurement. Include the required printed labeling information in the procurement order.
  2. Provide a service loop long enough in the ER/TRs to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum of 10 feet at each end.
  3. Provide pulling grip and install the cable in accordance with manufacturer-recommended practices.
  4. Connect MTP connectors into universal modules.

### 3.4 LABELING AND ADMINISTRATION

- A. Cables:
  1. Label Location: Affix labels at each end of the cable, within 6 feet of telecommunications room entrance and again within 12" of termination point.
  2. Fiber Optic Cables shall be labeled in the form of "##SM to RM#, ??FT" where "##" is the number of strands, "SM" is the fiber type, "RM#" is the telecommunications room where the far end of the cable is terminated, and ?? is the cable length.
    - a. For example: A 12-strand single mode cable running between telecommunications rooms "1W" and "2E" with a length of 62 feet would be labeled as follows:
      - 1) In telecommunications room 1W, the label would read "12SM to 2E, 62FT"
      - 2) In telecommunications room 2E, the label would read "12SM to 1W, 62FT"
  3. Copper Backbone Cables shall be labeled in the form of "BCxx" where BC is Backbone Copper and "##" is the BC cable number.
    - a. For example: A set of six Cat6A backbone cables running between rooms would be labeled as follows:
      - 1) BC01 – BC06
- B. Fiber Optic Patch Panels:
  1. Fiber optic patch panels shall be labeled on the face of the patch panel with a sequential alpha lettering ("A", "B", "C", etc.) across all patch panels in the telecommunications room. Skip letters "I" and "O" to avoid future misinterpretation of them as the numbers one and zero.
    - a. For example: The first Fiber Optic Patch Panel in the room shall be labeled "Fiber Optic Patch Panel A" and the second shall be labeled "Fiber Optic Patch Panel B." Do not restart the lettering for patch panels in different racks.

2. Connector panels (bulkheads) in fiber optic patch panels shall be labeled on the face of the fiber termination box with the same identifier as the cable that terminates in the connector panel. See paragraph A above.
- C. Before applying the cable numbering scheme described above, verify that the room numbers shown on the drawings match the actual room numbers that appear on building signage. The room numbering scheme may change between design and construction. All labeling and numbering schemes that incorporate room numbers shall reflect the finished, as-built room numbering, which may be different than the numbering shown in the construction documents.

### 3.5 TESTING

- A. Test the SCS after installation for compliance with all applicable standards as follows:
  1. Intrabuilding Backbone Copper: Test all cable pairs for length, shorts, opens, continuity, polarity reversals, transposition (wire map), and the presence of AC voltage. All pairs shall demonstrate compliance to TIA/EIA 568-D Category 6A standards.
    - a. Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer's recommended calibration period, with the most current software revision based upon the most current TIA/EIA testing guidelines, capable of storing and printing test records for each cable within the system.
      - 1) Fluke DSX-5000 CableAnalyzer™
      - 2) Fluke DSX-8000 CableAnalyzer™
      - 3) or approved equal.
  2. Fiber: Test fiber optic cable after installation.
    - a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
      - 1)  $\text{Max Loss} = [(\text{allowable loss/km}) * (\text{km of fiber})] + [(.3\text{db}) * (\# \text{ of connectors})]$
      - 2) A mated connector-to-connector interface is defined as a single connector for the purposes of the above formula.
      - 3) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).
    - b. Test all strands using a bi-directional end-to-end optical transmission loss test instrument (such as an OTDR) trace performed per ANSI/TIA/EIA 455-78 and a bi-directional end-to-end power meter test performed per ANSI/TIA/EIA 455, and ANSI/TIA/EIA 568-D.
      - 1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
      - 2) Provide test measurements as follows:
        - (a) Test singlemode cables at both 1310 and 1550 nm.
    - c. Test results shall conform to:
      - 1) The criteria specified in ANSI/TIA/EIA-568-D.
      - 2) The Contractor's calculated loss budget above.
      - 3) The criteria specified in the most recent edition of IEEE 802.3 and its related amendments for 10GBase-X 10 Gigabit Ethernet.
        - (a) In addition to the above, perform tests both recommended and mandated by the manufacturer. Tests shall confirm/guarantee compliance with the manufacturer's performance standards and also IEEE 802.3 for a maximum end-to-end dB loss of 2.5 dB.

- B. Cables and equipment that do not pass tests shall be identified and discussed with the Owner and Engineer. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Engineer in the same manner as above.
1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable "repairs" are not acceptable. The procedure for removing the cable shall be as follows:
    - a. Prior to removal of damaged cable and installation of new cable:
      - 1) Inform the Owner and Engineer of the schedule for the removal and installation.
      - 2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
      - 3) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
    - b. Remove the damaged cable and provide new cable.
    - c. After the removal of the damaged cable and installation of the new cable:
      - 1) Test the new cable per the paragraph titled TESTING.
      - 2) Test cables that occupy the same innerduct or conduit as the damaged cable per paragraph B, above, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
      - 3) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
      - 4) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
    - d. If a cable which occupies the same innerduct or conduit as a damaged cable is damaged by the extraction and reinstallation process, replace the cable at no additional expense to the Owner.
      - 1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.
- C. Provide test records on a form approved by the Owner and Engineer. Include the test results for each cable in the system. Submit the test results for each cable tested, with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Engineer for review and acceptance within two weeks of Substantial Completion.
1. Print test records in Adobe PDF format for each cable directly from the test software and submit in electronic form (in Adobe PDF and native Fluke test files) on CDROM to the Owner and Engineer for review. Handwritten test results will not be accepted.
  2. Any cabling discovered to have unsatisfactory test results shall be reterminated or replaced and retested.
  3. After all performance and testing issues have been addressed, resubmit the complete set of corrected test reports to the Owner and Engineer on CDROM.

END OF SECTION

## SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of an inside plant telecommunication system. This section includes Inside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System (SCS - See Definition Below).

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete communications Structured Cabling System (SCS) that is compliant with ANSI/TIA/EIA, NECA/NEIS and ISO/IEC standards as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of 10 Gigabit Ethernet operation as specified in TIA/EIA 568.2-D, ISO/IEC 11801-1:2017 and ISO/IEC 11801-2:2017.
- B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

#### 1.3 SEQUENCING

- A. Provide coordination with the cabling manufacturers to ensure that manufacturers' inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any manufacturer-required modifications and have manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.
- B. The Contractor is solely responsible for all costs associated with scheduling the manufacturer inspection, the inspection itself and any manufacturer-required re-inspections, and for any modifications to the installation as required by the manufacturers.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. SCS components shall be manufactured by the manufacturers listed below. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the SCS Manufacturer Warranty (see PART 1 - WARRANTY).
  - 1. Bid only the following SCS Manufacturers and only bid manufacturers for which the Contractor is certified. The SCS Manufacturers shall be the following. Substitution is not

- acceptable:
  - a. CommScope, for copper-related products
  - b. Corning, for fiber-related products
- B. All copper-related components shall be part of the copper SCS product line – components shall not be intermixed between manufacturers’ SCS product lines. The SCS product lines shall be engineered “end-to-end” – the system and all of its components shall be engineered to function together as a single, continuous transmission path.
  - 1. The SCS Product Line shall be the following, per manufacturer. Substitution is not acceptable:
    - a. For Category 6A Copper Distribution: CommScope Uniprise Category 6A cabling products with CommScope termination products.
    - b. For Fiber Optic Distribution: Corning horizontal solutions.

## 2.2 PATCH PANELS

- A. Copper Horizontal Distribution Patch Panels (Workstation Patch Panels): Complete with pre-manufactured cable management for supporting station cable behind the patch panel, and with incidental materials necessary for mounting. Terminations shall include universally color-coded wiring pattern for both T568A and T568B. Shall exceed the transmission performance requirements for connecting hardware, as specified in TIA/EIA 568.2-D, ISO/IEC 11801-1:2017 and ISO/IEC 11801-2:2017. Copper patch panels shall be manufactured by the selected SCS Manufacturer:
  - 1. Category 6A Unshielded – CommScope Uniprise Category 6A (for telecommunications applications):
    - a. 24-Port Discrete: CommScope 760237040/CPD-UDDM-SL-1U-24
    - b. 48-Port Discrete: CommScope 760237041/CPD-UDDM-SL-2U-48
  - 2. Cable Management Bar:
    - a. Middle Atlantic LBP-4R90
    - b. CommScope 557548-1
    - c. SEMTRON CMB-20.375X4\*BK
- B. Fiber Optic Patch Panels for Horizontal Distribution: Provide separate connector panels for horizontal applications, sharing the fiber optic patch panel used for backbone cabling. See Section 271300.

## 2.3 CONNECTORS

- A. Data Copper Connectors (modular jacks): 8-position/8-conductor, insulation displacement connection (IDC), non-keyed, and shall accept modular 8-position/8-conductor plugs, and with a universally color-coded wiring pattern for both T568A and T568B. Shall exceed the transmission performance requirements for connecting hardware, as specified in TIA/EIA 568.2-D, ISO/IEC 11801-1:2017 and ISO/IEC 11801-2:2017:
  - 1. Category 6A: CommScope:
    - a. Unshielded: CommScope 760241140/USL10G-ORG (Station End)
    - b. Unshielded: CommScope 760241138/USL10G-BLK (Panel End)
    - c. Unshielded Keystone: CommScope 760241163/UKJ10G-ORG (Station End)

## 2.4 STATIONS

- A. Faceplates: Complete with port identification labels and blank inserts/fillers for covering unused connector openings:
  - 1. SL Series Faceplate Kit for outlets mounted in standard single gang backboxes:
    - a. 2-Port: CommScope 1-2111009-x
    - b. 4-Port: CommScope 1-2111011-x
    - c. 6-Port: CommScope 1-2111012-x
    - d. 1-Port: CommScope 1-2111008-x (for use wall phone locations only)
  - 2. Blank inserts: CommScope 1116412-x
- B. Faceplate Mounting Brackets: Suitable for mounting faceplates over wall cutouts (i.e. flush-mount faceplates with no in-wall outlet box).
  - 1. For CADDY:
    - a. Single gang brackets: CADDY MPLS
    - b. Double gang brackets: CADDY MPLS2
- C. Surface Housing: Complete with port identification labels and blank inserts/filler for covering unused connector openings:
  - 1. One Port: CommScope PN# 1-1116697-3
  - 2. Two Port: CommScope PN# 1-1116698-3
- D. Surface Device Boxes: Color shall match the color of the electrical power receptacles in the application space. Boxes shall be single or double gang as required for the application:
  - 1. Single gang:
    - a. Wiremold 2344
    - b. Panduit JB1DEI-A
  - 2. Double gang: Wiremold 2344-2
  - 3. or approved equal
- E. Fiber Optic Outlets:
  - 1. Corning SPH-01P with Singlemode Simplex SC connector panel CCH-CP06-3C
  - 2. Corning SPH-01P with Singlemode Duplex LC connector panel CCH-CP06-A9

## 2.5 CABLE

- A. General: Cables shall be manufactured by the selected SCS Manufacturer.
- B. Copper Cable: 4-pair UTP, 23 AWG, NEC/NFPA CMP or CMR rated, with solid copper conductors.
  - 1. Category 6A: Shall meet or exceed channel specifications of TIA/EIA 568-D, ISO/IEC 11801-1:2017 and ISO/IEC 11801-2:2017 Class EA up to 500 MHz when used as a component in a properly installed CommScope F/UTP channel. Cabling shall comply with

all of the performance requirements for current and proposed applications such as 10 Gigabit Ethernet (1000BASE-Tx), 10/100/1000BASE-Tx, analog and digital video, analog and digital voice, VoIP, and shall exceed all requirements for IEEE 802.3 for 10 Gigabit Ethernet on all parameters.

a. Unshielded

- 1) Non-plenum: CommScope Uniprise CS44R
  - (a) Blue Jacket
- 2) Plenum: CommScope Uniprise CS44P
  - (a) Blue Jacket

2. Wet Applications, Category 6A: Shall meet or exceed channel specifications of TIA/EIA 568-D, ISO/IEC 11801-1:2017 and ISO/IEC 11801-2:2017 Class EA when used as a component in a properly installed channel. Cabling shall comply with all of the performance requirements for current and proposed applications such as Gigabit Ethernet (1000BASE-Tx), 10/100BASE-Tx, analog and digital video, analog and digital voice (VoIP) on all parameters.

a. Commscope 874019204/10 CS44P-IO BLU (Blue Jacket)

C. Fiber Optic Cable: Singlemode Fiber: Graded index, tight-buffered cable.

1. Singlemode 8.3/125  $\mu$ m: Maximum attenuation of 0.4 dB/km @ 1300 nm and 0.3 dB/km @ 1550 nm. Cable shall be non-pinned and non-armored plenum or riser rated as required by code. A pulling grip shall be provided for the pulling-end of the cable. Cable shall be manufactured by the selected SCS Manufacturer and shall be

- a. Corning: Corning MIC and Unitized MIC
- b. Corning: Armored Corning MIC and Unitized MIC
- c. Corning: FREEDM

D. Hook and Loop Cable Managers: Reusable hook and loop (similar to Velcro) style, 5/8" wide, 15-foot- long roll, black:

1. Panduit HLS-15R0
2. CommScope 1375255-2
3. Velcro ONE-WRAP
4. Or approved equal

## 2.6 HORIZONTAL FIBER OPTIC CABLING FOR FIRE ALARM CONTROL PANELS

A. Fiber Optic Cable: Red-jacketed, 2-strand, singlemode fiber optic cable.

1. For pathways that route through attics or outdoors, exposed to potential bat damage: Corning Armored MIC
2. For pathways that protect the cable from bat damage: Corning MIC

B. Fiber Optic Splice Tray inside Fire Alarm Control Panel:

1. Corning M67-076

C. Fiber Optic Connectors:

1. Use UltraPC (UPC) polished, ceramic connectors only. Do not use Angle Polish Connectors (APC).

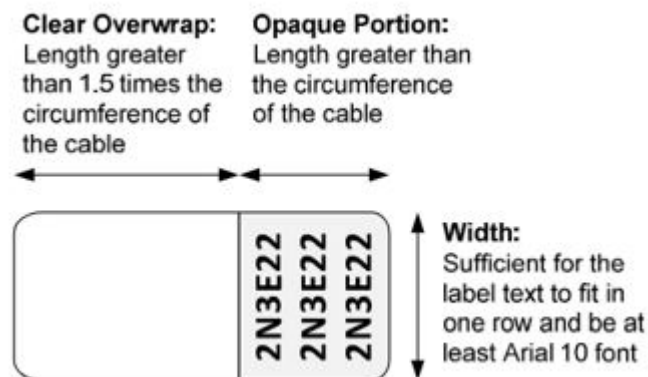


2. At the patch panel: LC-duplex Connector Panel, Corning CCH-CP06-A9
  3. Inside the Fire Alarm Control Panel: Coordinate with the Fire Alarm Contractor to determine which of the following two options to provide on a case-by-case basis:
    - a. 2-strand pigtail with duplex SC connectors
    - b. 2-strand pigtail with duplex ST connectors
- D. Fiber Optic Patch Cord: Red-jacketed, 3-feet long, pre-manufactured (factory-terminated) with a UL rating of OFNR. Fiber patch cords shall have UltraPC polished, ceramic, UPC connectors:
1. Singlemode, duplex LC-to-LC: Corning 04 04 G 003 F (Red)

## 2.7 LABELING AND ADMINISTRATION

### A. Labels:

1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
2. Labels shall have black text printed on white media.
3. Labels for Horizontal Cable shall be as follows and as shown in the diagram below:



- a. Brady: M-143-427 Self-Laminating Vinyl Labels
- b. or approved equal.

### B. Hand-carried label maker

1. Brady BMP41/51 Label Printer
2. or approved equal

## PART 3 - EXECUTION

### 3.1 PATCH PANELS

- A. Provide patch panels and horizontal wire management according to locations, elevations, and plan views as shown on the Contract Documents.

1. Copper: Size and install rack-mounted patch panels as shown on the Contract Documents. Use patch panels to terminate copper horizontal cables.
2. Cable Management Bars:
  - a. On the rear of the rack, provide cable management bar for each copper patch panel to support cables being terminated on the back of the patch panel.
  - b. On the front of the rack, provide cable management bar between patch panels for patch cord lacing, as indicated on the rack elevation diagrams.
3. Fiber: Size and install rack-mounted patch panels as shown on the Contract Documents and as indicated in Section 271300. Use fiber patch panels to terminate both backbone and horizontal fiber optic cables.

### 3.2 CONNECTORS

#### A. Copper Connectors (modular jacks):

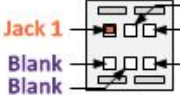
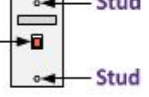
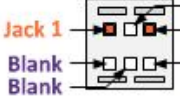
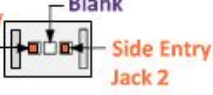
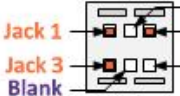
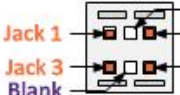
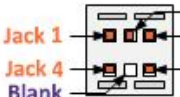
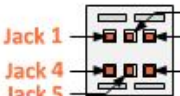
1. Provide Data connectors and install using T568B wiring pattern.
2. Punch down cable using only the selected SCS Manufacturer-approved impact tool.

#### B. Copper Plugs:

1. Provide Data plugs only for specifically designated field-connectorized applications and install using T568B wiring pattern.
2. Terminate cables using manufacturer-approved tools and methods.

### 3.3 STATIONS

- A. Faceplates: Provide faceplates for stations in the locations and gang counts shown on the Contract Documents. Faceplates shall completely conceal outlet boxes, reducer plates, etc. Faceplates shall provide a snug and sure fit for connectors – loose connectors are not acceptable. See diagram below for jack ordering and arrangement.
- B. Faceplates for Surface Raceway and System Furniture applications: Provide faceplates or bezels as required for the application. Mount two jacks per 3-port faceplate, and provide a blank insert in the middle port to provide space for cabling at the rear of each jack. See diagram below.

Outlets with <b>1</b> Cable	 <p>Jack 1 Blank Blank</p>	 <p>Stud Wall-mounted Telephone Outlet Jack 1 Stud</p>
Outlets with <b>2</b> Cables	 <p>Jack 1 Blank Blank</p> <p>Blank Jack 2</p>	<p>Surface Raceway Maximum <b>2</b> Cables per Outlet</p>  <p>Side Entry Jack 1 Blank Side Entry Jack 2</p>
Outlets with <b>3</b> Cables	 <p>Blank Jack 1 Jack 2 Blank</p> <p>Jack 3</p>	
Outlets with <b>4</b> Cables	 <p>Blank Jack 1 Jack 2 Blank</p> <p>Jack 3 Jack 4</p>	
Locations with <b>5</b> Cables	 <p>Jack 2 Jack 1 Jack 3 Blank</p> <p>Jack 4</p>	
Locations with <b>6</b> Cables	 <p>Jack 2 Jack 1 Jack 3 Blank</p> <p>Jack 4 Jack 5</p>	

- C. Flush-mount connectors in faceplates. For all outlets mount all connectors in 90-degree (straight) orientation (not angled).
- D. Where a faceplate has more ports than the number of cables that will terminate in it, terminate cables in the positions indicated in the diagram above. Provide blank inserts for any unfilled connector positions.
- E. Surface Device Boxes: Provide surface mount device boxes and faceplates as required and as shown for surface mounted communications outlets.

### 3.4 CABLE

- A. Plenum-rated vs. non-plenum-rated cabling: Most horizontal cabling applications at Clemson facilities are designed to permit non-plenum-rated cabling. If a cable is run entirely via conduit and junction boxes or does not pass through a plenum-rated space, then provide non-plenum (CM/CMR, OFNR) rated cable. Otherwise, provide plenum (CMP, OFNP) rated cable. Cabling shall bear plenum or non-plenum markings for the environment in which it is installed.
- B. Wet applications: Provide indoor/outdoor, plenum-rated cabling to all outdoor horizontal applications and all applications where the cabling passes through conduit in or under a slab-on-grade floor. Terminate this cabling in the telecommunications room without intermediate splicing or consolidation point. Floor boxes in upper floors (above the slab-on-grade floor) are

not considered wet applications.

C. All cabling:

1. Do not paint cabling. Painted cabling will not be covered by the manufacturer's warranty.
2. Provide horizontal cable in types, sizes, and quantities as defined by the Symbol Schedule and as shown on the Contract Documents. Install cabling between the station and its associated telecommunications room and patch panel. Provide one cable for each data connector at each station. Unless otherwise specified, provide white-colored cables.
3. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
4. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
  - a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.
  - b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
  - c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.
5. Install cable in a continuous (non-spliced) manner unless otherwise indicated.
6. Install exposed cable parallel and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
7. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's installation recommendations. Do not over-tighten tie wraps or cause cross-sectional deformation of cabling.
8. Support cabling through elevation changes greater than 24 inches.
9. Provide service loops with a minimum length of 10 feet in the telecommunications rooms and 12" in cable tray at point of horizontal conduit termination.
  - a. For cables that are within distance limitations, route cabling around telecommunications room before terminating, creating a usable service loop. For cables that would not otherwise meet distance limitations, do not route first around the room (do not provide this service loop).
10. Cable in the telecommunications rooms:
  - a. Lay cable neatly in upper ladder rack in evenly-sized loose bundles (no more than 24 cables per bundle) and loosely secure cabling to the ladder rack at regular intervals with cable manager straps. Do not use tie-wraps.
  - b. Route cables to patch panels on racks via ladder rack, across top of rack and then down vertical cable management to patch panel.

D. Copper Cable:

1. The following tool shall be used to terminate all horizontal cabling: TE SL series termination kit, TE 1725150-1 or equal Commscope product. The use of any tool that is not provided by the manufacturer and recommended by the manufacturer for this purpose is prohibited.
2. Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.
3. For shielded cable, bond both ends of the metallic shield (or metallic strength) member to the nearest TGB (as furnished under Division 27 Section — "Grounding and Bonding for

Communications Systems”).

4. Route station cable that is exposed (not in conduit) to comply with ANSI/TIA/EIA-569 requirements for avoiding potential EMI sources and as follows:
  - a. 48 inch separation distance from motors or transformers
  - b. 12 inch separation distance from conduit and cables used for electrical power distribution
  - c. 5 inch separation distance from fluorescent lighting. In telecommunications rooms, raise pendant fluorescent light fixtures such that they are at least 12 inches away from copper cabling.

E. Fiber Optic Cable:

1. Terminate all fiber strands within a fiber cable. The installation of “dark fiber” is not acceptable.
2. Provide separate CCH Connector Panels for horizontal fiber optic cables, mounted in shared fiber optic patch panels used for backbone fiber optic cabling.
3. For metallic shielded (armored) cable, bond both ends of the metallic shield (or metallic strength) member to the nearest TGB (as furnished under Division 27 Section — “Grounding and Bonding for Communications Systems”).
4. Provide a service loop long enough in the ER/TRs to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum of 10 feet at each end.
5. The service slack stored inside the fiber patch panel cabinets shall be 1 meter length.

F. Provide hook-and-loop cable managers for managing horizontal cabling in the telecommunications rooms.

### 3.5 HORIZONTAL FIBER OPTIC CABLING FOR FIRE ALARM CONTROL PANELS

A. Fiber Optic Cabling:

1. Determine whether the cabling will route through attics or outdoors, where it would be exposed to potential bat damage, or whether it will route through cable tray and conduit indoors where it would be protected. Provide armored cabling where it would be at risk to bat damage, and provide indoor-rated MIC cable where the pathway will protect the cabling.
2. Route the cabling between the fire alarm control panel (FACP) and the fiber patch panel in the main telecommunications room (MDF), regardless of which floor the FACP and MDF are located on.

B. Fiber Optic Splice Tray and Connectors inside Fire Alarm Control Panel:

1. Provide a small splice tray and use an adhesive Velcro-type solution to attach the splice tray inside the FACP in a location indicated by the Fire Alarm Contractor.
2. Coordinate with the Fire Alarm Contractor to determine whether the FACP equipment will require SC or ST connectors.
3. Splice pigtail connectors to fiber optic cable.

C. Fiber Optic Connectors at Patch Panel:

1. Terminate fiber optic cable in fiber optic patch panel in MDF using a dedicated LC-duplex Connector Panel. Label the connector panel to indicate its dedicated use with the FACP.
2. Furnish uninstalled, a red singemode patch cord for use by the Fire Alarm Contractor to connect FACP to the campus fire alarm ring.

### 3.6 LABELING AND ADMINISTRATION

#### A. Copper Horizontal Distribution Patch Panels (Workstation Patch Panels):

1. Patch panels shall be labeled on the face of the patch panel with a sequential alpha lettering ("A", "B", "C", etc.) across all patch panels in the telecommunications room. Skip letters "I" and "O" to avoid future misinterpretation of them as the numbers one and zero.
  - a. Lettering shall start at the topmost panel in the 1st rack designated for cabling.
  - b. Lettering should be placed on the left side of the panel, centered.
  - c. Do not restart the lettering for patch panels in different racks.
  - d. Minimum 1" width adhesive nylon fabric thermal transfer label. Black on white, maximum font size.

#### B. Horizontal Cables:

1. At Outlet:
  - a. Label content shall be in the form of "FCRP###" where "F" is the floor of the telecommunications room where the copper patch panel is located, "C" is the "compass" location within the floor where the patch panel is located ("N", "S", "E" or "W"), "R" is the rack number, "P" is the sequential letter identifier of the copper patch panel, and "###" is the sequential port number on the patch panel that is used to terminate the cable. Cross reference connector labels with the Port Designation label on the Contract Documents
    - 1) Example: if an outlet on the second floor has two Category 6A cables running to the North telecom room on the second floor, and if the cables terminate in the 21st and 22nd ports in the 5th workstation patch panel (located in the 3rd rack) then the jacks in the faceplate and the cables behind the jacks would be labeled "2N3E21" and "2N3E22" respectively. Where labeling space is limited, it is permitted to combine labels, for example "2N3E21/E22".
    - 2) 3/4" Width, Black on White print, Maximum font size.
  - b. On cable (behind the faceplate), affix one label as follows:
    - 1) Overwrap label at the end of the cable within 4" of the cable end near the jack.
      - (a) On faceplate, affix multiple labels as follows:
        - (1) Insert labels inside clear plastic windows on front of faceplate.
2. At Outlets mounted above the ceiling: In addition to the labels described above, provide another label applied to the T-bar grid directly beneath the outlet. This label is intended to be inconspicuous while still being visible from the floor.
  - a. Label content shall match the label that appears on the overwrap cable label.
3. At Patch Panels: Affix label at end of the cable within 4" of the cable end near the patch panel termination point.
  - a. Label content shall match the label that appears at the faceplate.

### 3.7 TESTING

A. Test the SCS after installation for compliance with all applicable standards as follows:

1. Copper Horizontal Cables – Category 6A: Test all pairs of each copper station cable, in accordance with the field test specifications defined in the “Transmission Performance Specifications for 4-pair 100  $\Omega$  Augmented Category 6 Cabling” by the Telecommunications Industry Association (TIA); ANSI/TIA/EIA-568.2-D and related addendums. This document will be referred to as the Augmented Category 6 Standard. The test equipment shall comply with the accuracy requirements for the level III field testers as defined in the TIA Cat 6A Document. To the extent possible, perform tests with building electrical systems fully powered on (i.e. Lights, HVAC, etc.).
  - a. Test each end-to-end link (from the connector at the station to the connector or termination in the telecommunications room) utilizing sweep tests, for continuity, shield continuity, shorts, polarity, attenuation, installed length, transposition (wire map), mutual capacitance, characteristic impedance, resistance, ACR, Insertion Loss, Pair-to-Pair Near End Crosstalk (NEXT), Power Sum Near End Crosstalk (PSNEXT), Equal Level Far End Crosstalk (ELFEXT), Power Sum Equal Level Far End Crosstalk (PSELFEXT), Return Loss, and presence of AC voltage. Test each cable in both directions.
  - b. Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer’s recommended calibration period, with the most current software revision based upon the most current ANSI/TIA/EIA testing guidelines, capable of storing and printing test records for each cable within the system and equipped with the current Category 6A test adapters. Level IV testers as specified in Draft IEC61935-1 are also permitted.
    - 1) Fluke DSX-5000 CableAnalyzer™
    - 2) Fluke DSX-8000 CableAnalyzer™
    - 3) Fluke testers shall have the 10GB Kit (Fluke DTX10GKIT) with latest software and hardware releases for CommScope CAT-6A horizontal distribution cables
    - 4) or approved equal.
  - c. In addition to the above, perform tests both recommended and mandated by CommScope. Tests shall confirm/guarantee compliance to CommScope Ethernet Category 6A 10GB applications based on the data contained in the CommScope performance specifications.
2. Fiber Horizontal Cables: Test fiber optic cable after installation.
  - a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
    - 1) For Horizontal Distribution:
      - (a) Max Loss = 2.0db (per ANSI/TIA/EIA 568-D)
    - 2) For Backbone Distribution:
      - (a) Max Loss = [(allowable loss/km) \* (km of fiber)] + [(0.3db) \* (# of connectors)]
      - (b) A mated connector-to-connector interface is defined as a single connector for the purposes of the above formula.
      - (c) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).
  - b. Test all strands using a bi-directional end-to-end optical transmission loss test instrument (such as an OTDR) trace performed per ANSI/TIA/EIA 455-78 and a bi-

directional end-to-end power meter test performed per ANSI/TIA/EIA 455, and ANSI/TIA/EIA 568-D.

- 1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
- 2) Provide test measurements as follows:
  - (a) Test multimode cables at both 850 and 1300 nm.
  - (b) Test singlemode cables at both 1310 and 1550 nm.
- c. Test results shall conform to:
  - 1) The criteria specified in ANSI/TIA/EIA-568-D.
  - 2) The Contractor's calculated loss budget above.
  - 3) The criteria specified in the most recent edition of IEEE 802.3 and its related amendments for 10GBase-X 10 Gigabit Ethernet.
    - (a) In addition to the above, perform tests both recommended and mandated by the manufacturer. Tests shall confirm/guarantee compliance with the manufacturer's performance standards and also IEEE 802.3 for a maximum end-to-end dB loss of 2.5 dB.
- B. Cables and equipment that do not pass tests shall be identified and discussed with the Owner and Engineer. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Engineer in the same manner as above.
  1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable "repairs" are not acceptable. The procedure for removing the cable shall be as follows:
    - a. Prior to removal of damaged cable and installation of new cable:
      - 1) Inform the Owner and Engineer of the schedule for the removal and installation.
      - 2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
      - 3) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
    - b. Remove the damaged cable and provide new cable.
    - c. After the removal of the damaged cable and installation of the new cable:
      - 1) Test the new cable per the paragraph titled TESTING.
      - 2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
        - (a) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
      - 3) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
    - d. If a cable which occupies the same innerduct or conduit as a damaged cable is damaged by the extraction and re-installation process, replace that cable also at no additional expense to the Owner.
      - 1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.



- C. Provide the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Engineer for review and acceptance within two weeks of Substantial Completion.
1. Print test records in Adobe PDF format for each cable directly from the Fluke software and submit in electronic form (on CDROM or flash drive) to the Owner and Engineer for review. Handwritten test results will not be accepted.
  2. Also submit native Fluke test files downloaded from the tester in electronic form (on CDROM or flash drive).
  3. Any cabling discovered to have unsatisfactory test results shall be reterminated or replaced and retested.
  4. After all performance and testing issues have been addressed, resubmit the complete set of corrected test reports (in Adobe PDF and as native Fluke test files) to the Owner and Engineer on CDROM or flash drive.

END OF SECTION

## SECTION 27 32 00 - VOICE COMMUNICATIONS TELEPHONE SETS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and labor for the installation of specialty telephone equipment.

#### 1.2 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, specialty telephone equipment, and necessary appurtenances to provide complete, permanent emergency telephone systems as hereinafter specified and/or shown on the Contract Documents. The systems shall be compatible with the Owner's existing emergency telephone systems and with the local E911 emergency call handling center.
- B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant system.

### PART 2 - PRODUCTS

#### 2.1 ADA DOOR BELL

##### A. DORM ROOMS/APARTMENTS

- 1. Follow ADA 806 Transient Lodging Standards
- 2. Edwards Push-Button #620 Doorbell with #147-1 Blank Faceplate
- 3. System Sensor #SW-P with #LENSE-A wall mounted strobe with amber lens
- 4. Altonix #AL400ULX power supply
- 5. System Sensor #MDLW Sync module is needed if tied to fire panel
  - a. Fire Protection vendor to furnish, install, and wire in sync module

### PART 3 EXECUTION

#### 3.1 COMMISSIONING

- A. Work with the Owner's designated Telecommunications Representative to identify and install a suitable circuit for each telephone device. Connect circuits to telephones and coordinate with Owner to verify that calls can successfully be placed.
- B. Emergency telephone devices will be configured by the Owner.

#### 3.2 TESTING

- A. Testing of all cable and devices shall be conducted by the Contractor in accordance with manufacturer's requirements and shall demonstrate that the devices interoperate with the

Owner's existing systems.

- B. All tests shall be coordinated through and witnessed by the Owner's designated Telecommunications Representative.

END OF SECTION

## SECTION 27 41 00 - AUDIO-VIDEO SYSTEMS

### PART 1 GENERAL

#### 1.1 STIPULATION

- A. The specifications sections “General Conditions to the Construction Contract”, “Special Conditions” and “Division 01 - General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

#### 1.2 SUMMARY

- A. Contractors shall purchase and/or provide all materials, products, services; labor and equipment specified or needed to complete all Division 27 work.
- B. These specifications shall form the basis for implementation of the design, installation, inspection, and close-out process particular to the audiovisual systems.
- C. The Owner must approve any deviation from the specifications and guidelines in this document. All communications, correspondence, and approvals must be conveyed through the official project contacts of record such as the Architect and Construction Manager.
- D. Unauthorized deviations from these Specifications may result in redesign, reconstruction, reinstallation, or reprogramming at the contractor’s expense. Contractors shall obtain formal written approval prior to installation in order to deviate from these specifications.
- E. The contractor shall be responsible for all work as defined, noted, or reasonably implied as necessary to complete the contract for this project within the defined project schedule per design intent for complete and fully functional systems.

#### 1.3 REFERENCES

- A. General: When a discrepancy arises between the listed codes, standards or guidelines and the other standards contained in this document, it shall be brought to the attention of the Architect and Consultant immediately for resolution. In general, the more stringent of the two guidelines shall be implemented.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
  - 1. The following codes, associations, acts and agencies, as required by law:
    - a. ADA Standards Americans with Disabilities Act
    - b. Federal Communications Commission (FCC)
    - c. NFPA 70
    - d. National Electrical Safety Code (NESC)
    - e. Occupational Safety and Health Administration (OSHA)
  - 2. The current edition of the following standards:
    - a. National Electrical Manufacturers Association (NEMA)
    - b. TIA-568.0 Generic Telecommunications Cabling for Customer Premises

- c. TIA-568.1 Commercial Building Telecommunications Cabling Standard
- d. TIA-568.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard
- e. TIA-568.3 Optical Fiber Cabling Components Standard
- f. TIA-568-C.4, Broadband Coaxial Cabling and Components Standard
3. The current edition of the following guidelines:
  - a. BICSI TDMM Telecommunications Distribution Methods Manual
  - b. InfoComm, AV Installation Handbook
  - c. ANSI/Infocomm 10 Audiovisual Systems Performance Verification
  - d. InfoComm, Audiovisual Best Practices: The Design and Integration Process for the AV and Construction Industries

#### 1.4 WORK INCLUDED

- A. The work covered by this specification includes the installation of complete and fully functional systems, including all labor necessary to perform and complete such installation, all materials and equipment incorporated or to be incorporated in such installation, and all services, supervision, consumable items, fees, licenses, facilities, tools, and equipment necessary or used to perform and complete such installation.
- B. The installing Contractor shall be responsible for the following;
  1. Unless otherwise specified, supply only new equipment, parts, and material. Protect all equipment from construction dust and debris until final acceptance.
  2. The System Drawings indicate the general layout of the various items of equipment and their functional relationships. Section 27 41 16 provides a system description and equipment list. Layout of equipment, accessories, and conduit systems are diagrammatic unless specifically detailed and do not necessarily indicate every item required for a complete installation. It is the responsibility of the AV contractor to review system drawings and equipment lists and to provide any incidental equipment needed for a complete and operable system even if not specified or shown on drawings, without claim for additional payment.
  3. Refer to audiovisual floorplans, elevations, and conduit drawings for receptacle backbox location and quantity information. Also, refer to architectural reflected ceiling plans for exact location of ceiling-mounted devices.
  4. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
  5. Obtain all permits necessary for the execution of the work. Comply with all applicable local codes and regulations.
  6. Provide inserts, cover plates and accessories as required for a complete system.
  7. Supply and install miscellaneous steel, such as strut channel and threaded rod for ceiling mounted equipment.
  8. Provide project management and oversight for the installation of a complete audiovisual system.
  9. Prepare and submit component documentation shop drawings, outlet labeling drawings, cable pull/termination schedules, cable test results, and as-built drawings, manufacturer cut sheets and other documentation described herein.
  10. Verification of accuracy and completeness of equipment lists, dimensions, mounting details and equipment compatibility.
  11. Test equipment, tools, ladders, lifts, and scaffolding required for installation.
  12. Daily and final cleanup of debris caused by installation.

13. Quality control / commissioning of systems.
14. End user training and training material.

C. Related Work Specified Elsewhere

1. Electrical (26 00 00)
2. Communications (27 00 00)
3. Equipment - Projection Screens (11 52 13)
4. Equipment - Projector Lifts (11 52 23)

## 1.5 DEFINITIONS

- A. Owner: Clemson
- B. Architect: Bourdeaux
- C. Consultant: BrightTree Studios
- D. Bidder: Audiovisual contractor or other entity generating the response to this set of audiovisual bid documents.
- E. Audiovisual Contractor or Contractor: Company responsible for work under this section.
- F. Furnish: Procure and deliver the equipment to the job site, freight prepaid, for receipt, staging and installation by others.
- G. Install: Provide, store, unpack, and securely attach or mount equipment to structure following industry standards, approved shop drawings, and manufacturer recommendations.
- H. Provide: Furnish and install equipment.
- I. Provided by others and Not in Contract (NIC): Work related to this contract, but will be provided by parties other than the AV Contractor.
- J. Owner-Furnished Contractor Installed (OFCI) or Owner-Furnished Equipment (OFE): Equipment furnished by the Owner for installation by the Audiovisual contractor. The Audiovisual Contractor shall be responsible for installing and integrating this equipment as detailed herein.
- K. Installation Materials: Installed cable, loose cable, terminations, cable management, voice/data/video patch cords, adapters, I/O Panels, cable dressing, lacing bars, copper bus bars, labels, rack shelves, rack mounts, power strips/distribution and other materials as needed to install the systems.
- L. Refer to the Building Industry Consulting Service International (BICSI) ICT Terminology Handbook for a detailed list of technology related definitions.

## 1.6 SUBMITTALS

- A. Refer to Section 27 00 00 – Communications General

B. General

1. Contractor must provide submissions as described in this specification. Those submissions include:
  - a. Bid submission
  - b. Shop drawings
  - c. Bill of materials
  - d. Test reports
  - e. As-built drawings and close-out documentation
2. All submittals shall be delivered in electronic format as Excel. XLS or XLSX, AutoCAD 2019 or more recent .dwg (with bound Xrefs.) Word .doc or .docx, or combined PDF files via FTP posting, USB flash drive, or email.

C. Bid Submittal package: By date specified, to include:

1. Basis of bid documents, including
  - a. Itemized equipment costs for specified equipment or approved substitutions
  - b. Qualifications / References
  - c. Certifications (including certificate of bonding, if required)
  - d. Proposed payment terms
  - e. Proposed installation schedule

D. Shop drawing submission: No later than 30 days following award of contract provide shop drawings as one unified package.

1. Shop drawings shall be submitted in advance of construction to cause no delay in other Contractors' work. Shop drawings shall be submitted at such time to allow the engineer reasonable time to review shop drawings to make necessary corrections. Shop drawings shall consist of, but not be limited to:
  - a. Drawing Index and Title Page
  - b. Symbol Legend
  - c. Floor plan and reflected ceiling plan showing layout of audiovisual devices.
  - d. Control system layouts and digital signal processing block design.
  - e. Block diagrams: Provide block diagrams of proposed connections of all equipment that indicate equipment types, model numbers, a unique identifier for each piece of equipment, connector types and genders, cable type, and cable numbers.
  - f. Rack Elevations
  - g. Video Projectors: Provide a table that identifies the projector type, lens type, screen size and acceptable lens throw distance.
  - h. Provide detailed drawings of custom-fabricated mounts & panels.
  - i. Cable Pull list defining cable types, quantities, locations, and label information.
  - j. Prior to beginning control system code development, provide a draft set of each touch panel user interface for review and approval by Owner and AV consultant. Include page logic flow. Contractor is to adhere to pre-approved Owner standards and Owner GUI template, if applicable, for all panel layouts.
  - k. Provide a web interface for each space that has a touchpanel (example: Crestron XPanel, Extron Link License for User Interfaces, etc).
  - l. Provide control system touch panel programming file for final review and approval by Owner and AV consultant, noting all comments from prior review.
  - m. Provide audio DSP file for consultant review.

- n. IP Table for all Network devices: No later than 30 days following award of contract. Organize each list with the information presented, in the order that it appears in this specification, in 13 columns from left to right:
  - 1) System #
  - 2) System Name
  - 3) Manufacturer
  - 4) Model #
  - 5) Location
  - 6) Serial #
  - 7) MAC Address
  - 8) IP Address
  - 9) Subnet
  - 10) Vlan Name
  - 11) Default gateway
  - 12) Primary DNS
  - 13) Secondary DNS
- E. Bill of material submission: no later than 30 days following award of contract provide the following as one unified package:
  - 1. Bill of materials including proposed options such as color, finish, etc.
  - 2. Manufacturer product data sheets
  - 3. Test result submission: One week before acceptance testing provide the following:
    - a. System test and certification reports
    - b. Completed IP Table as listed above in 'Shop Drawing Submission'
    - c. Draft of "as-built" system diagrams. Electronic version to be sent to Owner and Consultant one week before acceptance testing. AV Contractor to have one paper copy in 18"x24" or larger sheets onsite. Paper copy is to be new, current without any mark-ups.
- F. As-built drawings and close-out documentation: Within 30 days after final acceptance testing visit provide the following:
  - 1. "As-Built"/Record drawings, in CAD and PDF formats, consisting of Floor Plans, Reflected Ceiling Plans, System Block drawings, Rack Elevations, and Wall and Rack Plate Details.
  - 2. Documentation of performance test results.
  - 3. Documentation of the system settings prior to and after the system start-up.
  - 4. Provide drawings showing all equipment components and wires. Label all devices with manufacturer, model number, and instance number.
  - 5. Provide layout drawings of panels and other custom assemblies.
  - 6. Label connectors, barrier strips, switches, relay sockets, etc., for terminal number.
  - 7. Control software for AV control system, digital signal processors, and other programmable devices. Include complete job-specific source code files.
  - 8. Completed IP Table as listed above in 'Shop Drawing Submission'.

## 1.7 BID SUBMITTALS

- A. Instructions to Bidders: To be considered, bids must be made in accord with the Architect's Instructions to Bidders and this section.



- B. Examinations: Carefully examine the contract documents and the construction site to obtain first-hand knowledge of existing conditions. Contractors will not be given extra payments for conditions that can be determined by examining documents on-site and will not be relieved of any obligations with respect to bid.
- C. Equipment for the project is shown on the plans, reflected ceiling plans, elevations, and functional diagrams and Appendix A of section 274116. The contractor must develop a list of equipment for each type of space detailed on the drawings. The contractor is responsible for providing all miscellaneous parts to provide a complete and working audiovisual system in each of the spaces outlined in the drawings.
- D. Questions: Submit all questions about the contract documents in writing. Replies requiring changes to the contract documents will be issued to all bidders as addenda and will become part of the Contract. The Owner may give but will not be responsible for oral clarifications.
- E. Acceptable Products: Model numbers and manufacturers identified herein indicate a standard of quality and performance. Other products will be considered, subject to approval of complete technical data and results of independent testing of proposed equipment. The bidder may be required to provide samples to the consultant for evaluation.
- F. Master Quotes:
  - 1. Bidders shall reference the following manufacturer master quotes and the awarded contractor shall order the equipment using the latest revision of the master quote number.
- G. Substitutions: To obtain approval for substitutions and for items identified as "approved equal", submit written requests at least 10 days before bid date. Requests received after this time will not be considered. Requests shall clearly describe the product for which approval is asked, including all data necessary to demonstrate acceptability. If the product is acceptable, an Addendum may be issued to all bidders.
- H. Equipment Availability: Verify with manufacturers the availability and cost of all equipment proposed, including equipment specified herein. No cost increases will be allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment.
- I. Basis of Bids
  - 1. Submissions will be provided in electronic format described below. Electronic submissions must be supplied in Microsoft Excel. \*.xls or \*.xlsx format.
  - 2. Include a complete itemized list for each base-bid system indicating the manufacturer, model number, unit cost and total costs for all specified items.
  - 3. Provide line item pricing for all equipment.
  - 4. Provide details of allowances.
  - 5. Clearly indicate the total cost, including all expenses, for each individual system to allow the Owner to select any or all to be included in the contract.
  - 6. Provide separate line item pricing for installation labor.
  - 7. Provide separate line item pricing for control system programming labor.
  - 8. Provide separate line item pricing for documentation costs.
  - 9. Provide separate line item pricing for taxes.
  - 10. Provide separate line item pricing for shipping / delivery costs.

11. Provide separate line item pricing for travel expenses.
12. Organize each list with the information presented, in the order that it appears in this specification, in 8 columns from left to right:
  - a. System #
  - b. System Name
  - c. Manufacturer
  - d. Model #
  - e. Description
  - f. Quantity
  - g. Unit Cost
  - h. Extended Cost

SYSTEM #	SYSTEM NAME	MANUFACTURER	MODEL	DESCRIPTION	QUANTITY	UNIT COST	EXTENDED COST
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13. On a separate list, indicate costs of any specified add- or deduct- alternatives with the information presented in the same manner as for the base-bid system.
14. Include any notes or comments if necessary, to qualify the bid.
15. Include certification of ownership and full familiarity with the operation of the following minimum test equipment. Provide a list of the manufacturer, model, and serial number for each item of test equipment required.
  - a. Audio Test Equipment:
    - 1) Sound level meter and octave band filter set.
    - 2) Digital Multimeter.
    - 3) Calibrator with appropriate microphone adapter similar to General Radio, Norsonic, or Rion calibrators.
    - 4) Random or pseudo-random pink noise generator.
    - 5) Cable Tester
  - b. Video Test Equipment:
    - 1) HDMI test pattern generator capable of 1920x1080/60, 3840x2160/60 4:4:4.
  - c. LAN Test Equipment:
    - 1) CAT Cable Tester

- J. Provide a resume of qualifications consisting of a list of three recently completed projects of similar type and size with contact names, telephone numbers and email address for each. Jobs must be representative of the work your proposed team has completed.
- K. Provide resumes of experience for the Project Manager, Lead Engineer, Lead Field Technician, Audio DSP Engineer, and Control System Programmer who will be assigned to this project. Provide electronic copies of required certifications for proposed project team.

## 1.8 QUALITY ASSURANCE

- A. Project Management: Maintain the same person in charge of work throughout installation.
- B. Contract Documents: Maintain a complete set of system drawings and specifications at the site at all times during installation.
- C. Fabrication and Installation: Completely fabricate all equipment racks and subassemblies in contractor fabrication shop.
- D. Contractor Qualifications:

1. Lead Field Technician:
    - a. Shall have a current AVIXA Certified Technology Specialist - Installation (CTS-I) certification in good standing.
    - b. Shall provide all quality control (QC) and safety inspections as needed throughout the installation.
    - c. Shall conduct all AV system commissioning tests, and proof-of-performance testing/demonstration.
  2. On-Site Support Personnel:
    - a. CTS Preferred
  3. The control systems programmer assigned to the project shall be certified by the manufacturer.
  4. Audio DSP programmer assigned to the project shall have manufacturer's training and certification for specified system.
  5. Sub-contracting for AV work
    - a. Sub-contractors must conform to the same standards listed above and have prior approval.
- E. Work shall not proceed without the Owner's approval of all submitted items.
- F. It will be assumed that the Contractor has examined the shop drawings and equipment brochures prior to submission and that materials and equipment depicted will readily fit into the construction. Contractor shall also review all completed work related to materials or equipment depicted to ensure that it has been properly installed.
- G. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Contractor without such review and approval. The Engineer's review of such drawings and brochures shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications unless they have notified the Engineer in writing.
- H. Substitutions
1. General: The Contractor has the burden of proving, at the Contractor's own cost and expense and to the satisfaction of the Architect, that the proposed product is similar and equal to the named product.
  2. Basis:
    - a. Requests for acceptance of proposed equivalents made following the award of bid will be considered by the Owner and Consultant only in the following cases:
      - 1) The named products cannot be obtained by the Contractor because of strikes, lockouts, bankruptcies or discontinuance of manufacturer and the Contractor makes a written request to the Architect for consideration of the proposed equivalent.
      - 2) The proposed equivalent, in the opinion of the Owner and Consultant, is equal or superior to the named product and its use is to the advantage of the Owner.
    - b. A formal request must be made for the substitution documenting fully the above reason. Include complete data on the proposed substitution substantiating compliance with the Contract Documents including product identification and description, performance and test data, references and samples where applicable, and an itemized comparison of the proposed substitution with the products specified or named by Addenda, with data relating to Contract time schedule, design and artistic effect where applicable, and its relationship to separate contracts. Accompany the request by accurate installed cost data on the proposed substitution in comparison with the

## 1.9 SEQUENCING

### A. General

1. Coordinate work with adjacent work of other trades to facilitate construction and prevent conflicts.
2. Afford other trades reasonable opportunity for installation of work and for the storage of materials.
3. Staff the job to keep pace with the other trades.
4. Abide by the decision of the Architect in case of conflict or interference by other trades.
5. Refuse: Remove all refuse from the job site to the satisfaction of the Architect and Owner.

## 1.10 WARRANTY

- A. To maintain certain manufacturer's warranties, equipment must be installed, aligned, and serviced by those installers authorized by that manufacturer to perform those duties. If the Contractor is not authorized by the manufacturer, it is the Contractor's sole responsibility to make the appropriate arrangements and bear all cost and consequences.
- B. In cases where the manufacturer's warranty period is greater than specified in this Section, the Contractor shall provide that warranty for the full extent of the manufacturer's warranty period.
- C. In cases where the manufacturer's warranty period is less than one-year, the Contractor shall warrant the system(s) for one year. Additional years may be considered as an add-alternate to the base contract.
- D. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of Substantial Completion.
- E. In the case of Contractor-modified equipment, the manufacturer's warranty is normally voided. In such cases, the Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.
- F. In the event of malfunction or failure of any audiovisual equipment provided by the Contractor, the Contractor shall be responsible for replacement of faulty equipment or providing "loaner" equipment at no cost to the Owner for the duration of the repairs. If "loaner" equipment is provided, said equipment shall meet or exceed the original equipment's specifications until the original equipment is replaced.
- G. In cases where the Contractor is providing and installing audiovisual equipment and/or hardware to be integrated with equipment furnished by others, it shall be the responsibility of the Contractor to warranty their equipment as described in the Contract Documents unless said equipment shows misuse and or abuse by others during re-installation or connection of equipment by others.
- H. Equipment shall be serviced within 24 hours of first notification. If repairs cannot be completed during this time period, or if ordering of parts is required, the Owner shall be notified every 72

hours documenting progress of repairs. This repair capability is mandatory. Include costs anticipated to comply with this requirement in the bid.

- I. Contractor shall be responsible for and make good, without expense to the Owner, defects arising during this warranty period that are due to imperfect materials, equipment, improper installation, or poor workmanship.

#### 1.11 SERVICE CONTRACT

- A. Provide a one-year service contract to commence after acceptance of installation without additional cost. Service to include two semi-annual visits to the site for routine adjustment and maintenance of all equipment. Provide a preliminary schedule for the semiannual visits.

#### 1.12 TRAINING

- A. The Contractor shall provide a minimum of 12 hours of on-site training for, but not limited to, the Owner's staff at a time that is mutually agreeable for the Owner and Contractor.
- B. The Owner may choose to have the sessions spread out over several sessions and vary the staff being trained and the level of training. The final acceptance and/or final payment for the system(s) shall not be delayed due to scheduling delays beyond the control of the Contractor. The Contractor should also be available for additional training should the Owner request it.
- C. A training session(s) with the Owner's designated technical personal for routine and preventive maintenance shall be provided. The routine and preventive maintenance training session(s) shall show such items as filter and lens cleaning, minor equipment checks and "user" adjustments. This training is not meant to teach the Owner how to use commercial test equipment and/or sophisticated equipment/system alignment.
- D. The Contractor shall provide a System Operational Manual (not equipment O&M manuals) for each system that explains how to fully operate the system from start-up to shut-down and all operational steps in-between, in a step by step description, with pictures and other visual aides to help convey information.
- E. The Contractor shall coordinate with the Owner if they would like the training session recorded for the Owners reference, and to help limit minor follow up phone calls.

#### 1.13 INSPECTION

- A. Notify the Architect of any defects in work by other trades affecting installation.

### PART 2 PRODUCTS

#### 2.1 GENERAL

- A. Refer to section 274116 for equipment requirements.

## 2.2 MATERIALS AND EQUIPMENT

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- B. All products and materials shall be new and unused, clean, free of defects, and free of damage or corrosion prior to their installation as part of this project. Refurbished items are not allowed.
- C. Used or damaged equipment or material is not allowed.
- D. Materials shall bear UL label where applicable.
- E. Alternates may be proposed but shall meet or exceed specifications for the items listed. Acceptance shall be at the sole discretion of the Owner, Architect, or Engineer.
- F. Stock manufactured or custom-built equipment shall be supported by complete and detailed schematic drawings and replacement parts list. No unidentified components shall be acceptable.

## 2.3 WIRE AND CABLES

- A. See Section 27 41 16 Integrated Audio-Video Systems and Equipment for cable requirements by signal type.
- B. Cable passing through two or more floors shall be rated and marked for use in riser applications.
- C. Riser Cable shall be CMR or OFNR rated per NEC and comply with applicable codes.
- D. Cable in plenums shall be rated, listed, and marked for use in plenum applications.
- E. Plenum Cable shall be CMP rated per NEC and comply with applicable codes.
- F. Contractor shall verify all spaces as plenum or non-plenum with the architect/mechanical engineer prior to purchasing or installing cable.
- G. It is the responsibility of the contractor to comply with all plenum requirements of the Owner and the AHJ for all cables.

## 2.4 MISCELLANEOUS

- A. Contractor shall provide all screws, anchors, clamps, miscellaneous grounding, and support hardware necessary for installation of the system(s).
- B. Contractor shall furnish special installation equipment or tools necessary to properly complete the system(s). This may include, but is not limited to, tools for terminating cables, test equipment, jack stands for cable reels, and cable wrenches.
- C. Contractor shall furnish scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment. These items shall be removed from premises when no longer required.

Coordinate delivery and storage of these items with the Owner or Owner's Representative a minimum of 1-week prior to items arrival on-site.

- D. Contractor shall provide equipment with suitable lifting attachments to enable equipment to be lifted into its appropriate location. Lifting attachments shall be able to withstand handling conditions that might be encountered, such as rapid lowering and braking load, without bending or distorting shape.
- E. Any OFCI equipment on-site shall be removed, cleaned, tested for proper operation and installed in accordance with project guidelines. Any OFCI equipment provided for the project shall be installed in accordance with project guidelines.
- F. Coordinate the return or recycling of removed and/or replaced equipment with the Owner. Existing equipment not reused shall be returned to the Owner. The Contractor is required to properly recycle or dispose of equipment at no additional cost to the Owner upon request.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Contractor shall coordinate with all other trades prior to installation.
- B. The Owner shall not be responsible for delays in work because of shutdowns due to unsafe working practices by Contractors. Delays enforced by safety officials due to unforeseen environmental conditions in the work area may be out of Contractor's control. Contractors shall contact the Owner's primary project manager immediately if delays are incurred for safety reasons.
- C. It shall be the responsibility of the Contractor to secure any parking permits prior to the first day of work on-site.
- D. Work outside of normal operating hours and days shall be coordinated with the Owner's facilities management.

### 3.2 LABELS

- A. Except where otherwise specified each item of rack mounted equipment, all switches, controls, and receptacles shall be labeled as shown on drawings or as specified.
  - 1. Receptacles: Engrave and fill receptacle label directly on mounting plate as indicated on Contract Drawings.
- B. Identify all wires and cables at every termination and connection point with the specified cable markers. The contractor is strongly encouraged to use a numbering scheme that identifies all cables terminating at patch panel jacks with the patch bay row and jack designation; use A, B, and suffixes to distinguish multiple cables terminating at the same jack.
- C. All labels and legends shall be as approved on shop drawings.
- D. Cable Markers:

1. High-grade PVC clip-on or permanent-type cable markers with permanent markings, or printed vinyl tape protected by clear shrink tubing or adhesive wrap.

### 3.3 TESTING AND VERIFICATION

- A. Refer to individual sections for additional testing and verification requirements.
- B. Contractor will complete all testing for system operational compliance and test to ensure all equipment is working to published specifications.
- C. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents and subsequent Contractor submittals.
- D. The operation of all system equipment shall be demonstrated by the Contractor.
  1. The Contractor shall be responsible for providing test equipment for these tests.
  2. The Contractor shall be responsible for providing qualified personnel to test, make adjustments, and answer system questions to complete the tests and setup satisfactorily.
- E. The Contractor shall make available the personnel that programmed and/or configured the system, including control systems, audio DSPs, and network devices. These persons will be available to run requested demonstrations, make adjustments, and answer system programming questions for as long as required to accomplish the demonstration satisfactorily.
- F. Once system and programming is considered fully functional by the Owner or Consultant, it shall be used for a period of at least 10 days to be proven error free and perform accurately. No Trojans or codes are to be built into the software that restricts its use after a period of them. If the operating code is not error free in this 10-day period the Contractor will be required to make the proper code and function changes, at which point the 10-day error free period will once again commence. This cycle shall continue at the cost of the Contractor until all systems and codes operate properly and without error for the particular installation. The one-year warranty period for the software starts upon evidence that the code is correctly written and operating properly. This warranty is NOT tied to the building or hardware substantial completion date. The system and code is to be noted in writing as accepted by an Owner representative.
- G. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. The Owner will advise if training can commence while any further cleanup is being done before Completion.

### 3.4 FINAL ADJUSTMENTS AND ACCEPTANCE TESTS

- A. Assist the Consultant(s) in performing final system adjustments and acceptance tests. Provide all labor, material, tools, and measurement equipment necessary for these tests and adjustments.
- B. The Contractor shall supply sufficient representatives for assisting in performance of these tests, all of which shall be thoroughly familiar with all details of the system and shall include the Contractor's field supervisor in charge during the course of the installation.



- C. Adjustments: Adjust the system as instructed by the Consultant. Adjustments may be required to any portion of the system including:
1. Loudspeaker position/aiming.
  2. Equalization and level balance.
  3. Timing and functioning of the audiovisual control system.
  4. Video projector alignment, contrast, brightness, and color content.
  5. Network configuration.

### 3.5 PROGRESSIVE AND FINAL CLEANING OF PROJECT SITE

- A. During construction, and prior to the Owner's acceptance of the building, remove from the premises and dispose of packing material and debris caused by audiovisual work.
- B. Remove dust and debris from the interior and exterior of audiovisual equipment. Clean accessible current carrying equipment prior to being energized.
- C. Contractor shall clean work areas each day and remove debris properly and legally from the Owner's property. Audiovisual equipment and related materials installed or stored for use in the project shall be neatly stacked and remain free of debris, cable scraps, and accumulated dust. All exits and paths shall be cleaned to prevent dirt from being tracked throughout the facility.
- D. Upon completion of the work, remove excess debris, materials, equipment, tools, and similar items. Leave the premises clean, neat, and orderly.

### 3.6 COMPLETION

- A. Systems shall be complete and operational. Controls shall be set and calibrated.
- B. Testing, start-up, and cleaning work shall be complete.
- C. Contractor will complete a complete system(s) inventory of all equipment and inspection of all workmanship relating to the installation.
- D. All final "as-built" drawings and close-out documents shall be delivered to the Owner within 2 weeks of completion.

END OF SECTION

## SECTION 27 41 16 - INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT

### PART 1 GENERAL

#### 1.1 STIPULATION

- A. The specifications sections “General Conditions to the Construction Contract”, “Special Conditions” and “Division 01 - General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

#### 1.2 SUMMARY

- A. This section shall form the minimal requirements for the basis of implementation of the design, installation, inspection and close-out process for the audiovisual system.
- B. The Owner must approve any deviation from the specifications and guidelines in this document. All communications, correspondence, and approvals must be conveyed through the official project contacts of record such as the Architect and Construction Manager.
- C. Unauthorized deviations from these Specifications may result in re-design, reconstruction, or re-installation of physical communications elements at the Contractor’s expense. Contractors shall obtain formal written approval prior to installation in order to deviate from these specifications.
- D. The Contractor shall be responsible for all work as defined, noted, or reasonably implied as necessary to complete the contract for this project within the defined project schedule per design intent for complete and fully functional systems.

#### 1.3 SYSTEM DESCRIPTIONS

- A. SY1 - [SYSTEM NAME]
  - 1. Scope Description
  - 2. Video Sources
  - 3. Video Destinations
  - 4. Audio Sources
  - 5. Audio Destinations
  - 6. Audio and Video Distribution
  - 7. Infrastructure/Furniture
  - 8. Control System
  - 9. Network

### PART 2 PRODUCTS

#### 2.1 CABLING

- A. All This table lists common AV applications and appropriate cabling for each application. Single channel cabling is listed but multichannel cabling (multiple individual circuits with

dedicated outer jackets inside a common outer jacket) is acceptable in some applications. The contractor shall submit cabling part numbers as part of the submittal process. Where cable selection is dependent on distance, the contractor shall identify in the submittal which system each type selected applies to.

APPLICATION	CABLE DESCRIPTION	NOTES
BALANCED AUDIO (MIC OR LINE LEVEL)	22 AWG STP STRANDED	
LOUDSPEAKER	UTP STRANDED	<b>GAUGE DEPENDENT ON AMPLIFIER/LOUDSPEAKER POWER.</b>
LV POWER SUPPLY	UTP STRANDED	<b>GAUGE DEPENDENT ON POWER SUPPLY REQUIREMENTS.</b>
SERIAL DIGITAL INTERFACE	75 OHM COAX	<b>CERTIFIED BY MANUFACTURER FOR 12G-SDI OPERATION OVER REQUIRED DISTANCE.</b>
HDBASET (<70M)	CAT6A UTP	
HDBASET (>70M)	CAT7A S/FTP	
USB EXTENSION	CAT6A UTP	
SERIAL CONTROL (RS-232/422/485)	24 AWG STP STRANDED	
ETHERNET	CAT6A UTP	
RF	50 OHM COAX	<b>TYPE DEPENDENT ON REQUIRED DISTANCE.</b>

#### B. Balanced Twisted Pair Cabling

1. All four pair balanced twisted pair cables shall be terminated at both ends to a jack in a patch panel, data biscuit, or wall plate and then connected to the equipment using a stranded, pre-made patch cable of the same category.
2. If the permanently installed cabling is shielded, the patch cables on both ends shall be shielded. The permanent link shall not exceed 90m in length and the patch cords used shall together not exceed 10m in length.
3. EIA/TIA T568B wiring scheme shall be used.

## 2.2 PATCH PANELS

### A. Custom Patch Panels

1. Material: Aluminum
2. Thickness: 0.125"
3. Edges: Bevels
4. Finish: Anodized. Confirm color with Architect.
5. Labeling:
  - a. Engraving: Machine Engraved
  - b. Text Height: Greater than or equal to 3/32".
  - c. Color: Contrasting plate color. Confirm color with Architect.
6. Size: Refer to drawings. Gang plates sizes shall conform to NEMA standards.

- B. AV back boxes may be shown on infrastructure plans for future use. If not directed to pull cabling to these locations in the specifications or drawings, provide a blank plate on all locations. Coordinate blank plate color with architect.

## 2.3 RADIO FREQUENCY PRODUCTS

- A. Prior to ordering wireless microphone systems, the Contractor shall conduct a radio frequency spectrum survey of the site and provide wireless microphone systems in appropriate frequency bands for the actual RF conditions on site. The Contractor shall provide to the owner a schedule of wireless microphone systems installed, the room in which they are installed, their frequency band, and programmed frequency.
- B. The Contractor shall provide to the owner a schedule of assisted listening systems installed, the room in which they are installed, the programmed frequency, and quantity of receivers provided in each room. If assisted listening system line level outputs are provided in the room for future or pool equipment use, the schedule shall note the location and type of jack.

## 2.4 OTHER

- A. The Contractor shall coordinate with the owner's information technology staff to ensure each device connected to the owner's enterprise network is connected to a jack with the appropriate network configuration for that device.
- B. For all products that are available in multiple color options, the Contractor shall confirm product color with the Owner or Architect prior to ordering.
- C. All projector mounts shall be locking types keyed the same. Provide the keys to the owner's representative following testing and acceptance. All flat panel display mounts shall have the ability to be locked by a padlock.

- D. If any specialized cables, adapters, converters, or electronics are required for general maintenance or basic configuration changes to included equipment, the AV contractor shall supply at least one of each type required to the owner during testing and acceptance.

END OF SECTION

## SECTION 27 83 06 – RADIO ENHANCEMENT SYSTEM

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes design, installation, and testing of a Radio Enhancement System (RES) as defined in IFC 510, NFPA 1221 and NFPA 72.

#### 1.2 REFERENCES

- A. NFPA 1 – Fire Code.
- B. NFPA 1221 – Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
- C. International Fire Code.
- D. National Electrical Safety Code.
- E. UL2524
- F. FCC Rules and Regulations 47 CFR.
- G. Telecommunications Industry Association (TIA)

#### 1.3 SYSTEM DESCRIPTION

- A. Provide an emergency responder radio coverage enhancement system per IFC 510 and install NFPA 1221.
- B. Coordinate with local AHJ for radio frequencies and bandwidth requirements prior to design. For bidding purposes assume the following:
  - 1. 700 MHz and 800 MHz Analog / Digital bands (T25 compliant).
- C. Prior to installation, test radio coverage throughout building per NFPA 72-24.5.2 to define areas where enhanced coverage is required. Submit drawing to architect showing areas where coverage is required. In lieu of Pre-Install testing, modelling may be provided to ensure coverage is obtained through building.
- D. For bidding purposes, assume system is required throughout entire building. A credit shall be provided to the owner once areas that require coverage is defined.
- E. Install system only where required per testing. Provide power requirements, including battery back-up, as required for system regardless of whether power is shown on drawings.

#### 1.4 SUBMITTALS

- A. Pre-Install Testing: Submit floor plan showing location of testing points and signal strength at each of those points.
- B. Design: Submit design information as required for review and approval. If requested by the Architect / Engineer, a design review meeting shall be held for the contractor to present the design submittal.
- C. Shop Drawings: Indicate electrical characteristics and connection requirements; cable routing; connection diagrams; and equipment arrangement.
  - 1. Equipment and component cut sheets.
  - 2. Submit detail drawings including panel and cabinet layouts, equipment interconnection diagrams, equipment and material lists.
  - 3. Note proposed location of exterior antenna on shop drawings.
- D. Product Data: Submit manufacturer's descriptive and technical literature, catalog data, and installation instructions showing electrical characteristics and connection requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of each item of equipment and show interconnecting wiring.
- B. Operation and Maintenance Data: Submit operator instructions for each required mode of operation, routine troubleshooting procedures, and manufacturer's operation and maintenance manual for each item of equipment and accessory.

#### 1.6 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.
- B. Maintain one copy of each document on site.

#### 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience, and with the ability to respond to service calls within 4 hours.

## 1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of equipment for one year 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 manufacturers:
  - 1. Honeywell.
  - 2. Mobile Communications.
  - 3. SideBand System.
  - 4. Bird Technologies.
  - 5. Substitutions: Division 01 Specification - Product Requirements.

### 2.2 GENERAL

- A. The RES system shall be designed and furnished to operate in the frequency band provided by the AHJ with the ability to make minor adjustments (within 50MHz) without component change.
- B. The RES system shall be designed to provide a minimum -90 dBm RF signal level, or a minimum of 10 dB above the RF noise floor, at any point within the building, or elsewhere as designated in the contract documents.
- C. The RES RF output shall be close-coupled to the RF input so as to prevent feedback saturation. The minimum output-to-input path loss shall equal the maximum operating gain of the amplifier plus 10 dB. System component selection and layout shall take this requirement into consideration when placing the RES system components in and around the building.
- D. The RES system shall be capable of accurately and properly amplifying and distributing radio signals without causing any sort of radio system degradation. It shall be capable of using the following modulation techniques and formats:
  - 1. Analog FM
  - 2. Digital FM
  - 3. EDACS™
  - 4. TDMA
  - 5. CDMA
  - 6. P25 Phase II
  - 7. GSM
- E. The RES system shall be FCC type-accepted and labeled as such prior to placing it into operation.



### 2.3 BI-DIRECTIONAL AMPLIFIER (BDA)

- A. Provide an all-inclusive and fully integrated BDA with UL2524 1<sup>st</sup> edition for in-building 2-way emergency radio communication enhancement system listing.
- B. BDA shall be monitored through fire alarm system control panel.
- C. The BDA shall be an automatic gain adjusting or OLC (output level control) type, where the gain is automatically set over a wide operating range. The BDA system shall be FCC type accepted and labeled as such prior to placing it into operation.
- D. An input signal level of -60 dBm is the nominal input signal level applied into the BDA system. The contractor shall take steps to augment local input signal reception to this level. If the contractor cannot make the input level reach the nominal level, the contractor shall notify the engineer, and provide the expected input signal level, and corresponding output level as part of the design submittal.
- E. The RES system shall amplify all signals within the specified frequency band. The effective output power per channel is reduced as more channels are amplified. The contractor must account for the reduction in signal strength when calculating the signal distribution within the building. The following table depicts the typical effect of multiple channel amplification.

<b>Number of Frequencies In The Passband</b>	<b>Maximum Output Power Per Single Channel</b>
2	24.7 dBm
4	20.0 dBm
6	17.5 dBm
8	15.5 dBm
10	14.1 dBm
20	9.8 dBm

- F. The maximum output power of the amplifier shall be set below the amplifier's 1 dB compression point to prevent damage to the amplifier and minimize signal distortion. If necessary, external attenuator pads shall be inserted before the electronic attenuator to prevent overdriving the BDA OLC circuitry.
- G. Decoupled RF test points shall be provided to permit performance testing or alignment while the RES is in operation. They shall be clearly labeled as test points and depicted on a block diagram with the rest of the RES circuitry.
- H. The RES system shall be powered by the building's electrical distribution system.
  - 1. A surge suppression device shall be provided as part of the RES system design, to protect the incoming power line from transients.
  - 2. Provide a backup electrical power supply capable of supporting entire RES system for a minimum of four hours. Provide recharging system for power supply and warranty power supply and charging system for a minimum of 1 year.

- I. Provide hinged door type, lockable cabinet to support RES system components. Cabinet shall be sized by contractor with adequate space inside the cabinet for servicing the unit. Provide a nameplate on cabinet that reads “RES System Cabinet #” where # indicates a number where multiple cabinets are required. Provide labels for internal components. Provide system schematic diagram inside a plastic sleeve on inside of each cabinet.
- J. If installed outdoors or in unprotected locations, the cabinet shall be weatherproof stainless steel NEMA 4X. All penetrations into the cabinet shall be made with RGS or IMC conduit, and weatherproofed.

## 2.4 EXTERIOR ANTENNA SYSTEM

- A. The exterior antenna system shall consist of a highly directional gain antenna, and antenna mount, coaxial lightning surge suppression, and a minimum ½” type LDF coaxial cable feed to the BDA. The specific size of the feed line coaxial cable shall depend on the system design. A short (2’ max) super flexible cable may be used to connect the antenna to the RF feed line cable. The exterior antenna shall be configured to mount on or near the building rooftop, at a location affording the best view towards the nearest radio repeater site. The antenna shall be oriented towards the nearest system repeater site. Coordinate exact location of antenna with architect prior to rough-in.
- B. A lightning surge suppressor shall be connected in the RF coaxial feed line in-between the antenna and the BDA. A copper grounding plate shall be provided with the surge suppressor, and bonded to the grounding system. Locate the surge suppressor inside the building at the cable penetration point. Building penetration for the RF feed line cabling shall be protected with an electrical service weatherhead and coaxial cable drip loop.
- C. The antenna system, antenna mast, coaxial cable, and surge suppressor shall be grounded by attachment to the building’s grounding system. The coaxial cable shall be connected to the ground system by means of the cable manufacturer’s shield grounding kit. A ground system connection to the coaxial cable shall be at both ends of the exterior-run cable if it exceeds 100 feet in length, otherwise within 20 feet of the building entrance. The coaxial lightning surge suppressor shall be grounded per the manufacturer’s recommendations. Grounding cables shall be sized according to manufacturer’s recommendations.
- D. The antenna installation shall be suitable for operation with wind loading of 95 mph. All components shall be suitable for outdoor installation. All outdoor RF connections and coaxial cable grounding kits shall be covered in weatherproof connector boot coverings.

## 2.5 INTERIOR ANTENNA SYSTEM

- A. The interior antenna system shall consist of a sufficient number of antennas and / or radiating cable distributed within the building to meet the -90 dBm, or 10 dB above noise floor, design criteria throughout the building. Coaxial power dividers shall distribute and balance the radio signals into appropriate branch circuits connecting back to the BDA.
- B. The coaxial cable shall be a minimum of ½” type foam dielectric low loss type. Radiating coaxial cable shall be minimum of 7/8” foam dielectric and shall be installed a

minimum of 2 inches off any wall surface. Cable jackets for any coaxial cables installed indoors shall be low smoke, non-halogen construction. Attachment between the cable and building shall be by plastic cable clamps, expressly designed for the application.

- C. Each splitter shall be mounted in a separate junction box located so as to be easily accessible for maintenance while maintaining security from unauthorized tampering. Each junction box shall be labeled externally.

### PART 3 EXECUTION

#### 3.1 COORDINATION

- A. Provide a copy of approved design submittals to the local AHJ prior to installation.

#### 3.2 INSTALLATION

- A. Consolidate all cabinets, back-up power supplies, and accessories in one location. Mount cabinets adjacent to each other. Coordinate location with all other trades prior to rough-in.
- B. Provide two 120-volt, 20 amp branch circuits to each RES system cabinet.
- C. All cabling shall be installed in metallic conduit (EMT). All exterior cable shall be installed in 2" conduit.
- D. Conduit penetration through roof shall extend to a minimum of two feet above the roof deck and be terminated with an electrical weatherhead.
- E. Riser cabling shall be a listed rated assembly when routed outside of stacked / rated electrical riser rooms.

#### 3.3 SYSTEM OPTIMIZATION

- A. The RES system shall be adjusted to the level of desired signal and avoid inter-modulation. Fixed attenuators may be used to set the BDA levels if required.
- B. THE BDA's OLC circuits shall provide a dynamic range of 30 to 40 dB. If the input level to the BDA causes continual output limiting, a fixed value coaxial RF attenuator shall be inserted at a point provided in the RES's input circuit.

#### 3.4 FIELD QUALITY CONTROL

- A. Perform all work necessary to plan, schedule, and conduct tests, and to complete the required documentation as specified in the contract.
- B. Perform operational test on each item of equipment and on system.

- C. Verify that the RES has been installed in accordance with the specifications, and the system performance criteria. This includes inspections, test, and measurements of the DC power, the BDA gain, and the signal levels within and outside of the building. Record all test measurements.
- D. Provide diagrams showing equipment placement and routing for antennas, coaxial cables, and AC power to the engineer prior to testing. After testing, provide another copy of the final documents inside the cabinet.
- E. Submit an Rf compliance certificate for the RES at the conclusion of acceptance testing.

END OF SECTION 27 83 06

SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. The security contractor shall provide a completely functional integrated physical electronic security solution as detailed here and within the project documentation.
- B. Provide labor, materials, coordination, and equipment necessary to complete the work of this Section, including but not limited to the following:
  - 1. Access Control System (ACS)
  - 2. Video Surveillance System (VSS)
- C. It is the intent of these specifications to provide a complete workable integrated security system ready for the Client's use as described within the project documentation. Any items not specifically detailed on the drawings or described in the Specifications, but normally required to conform to the intent, are to be considered as part of the Contract.
- D. These specifications are equipment and performance specifications. Actual installation shall be as indicated on drawings, specifications and/or contained within the manufacturers written installation instructions. Any discrepancies found between the specification, drawings and manufacturers' installation instructions shall be immediately brought to the attention of engineer/Client in writing at once. Installation and details indicated on the drawings shall govern if they differ from the specifications.

1.2 REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Related Documents and Sections:
  - 1. Division 01 – General Requirements
  - 2. Division 08 - Openings
  - 3. Division 26 – Electrical
  - 4. Division 27 - Communications
- C. The following codes, associations, acts and agencies, as required by law:
  - 1. American National Standards Institute/Electronic Industries Association/Telecommunication Industries Association (ANSI/EIA/TIA)
  - 2. Federal Communications Commission (FCC)
  - 3. National Fire Protection Association (NFPA)
  - 4. NFPA-70, 2011 (National Electric Code)
  - 5. National Electrical Safety Code (NESC)
  - 6. National Electrical Manufacturers Association (NEMA)
  - 7. Occupational Safety and Health Administration (OSHA)
  - 8. UL Standard for Safety

9. International Building Code
10. International Fire Code
11. Any additional applicable local codes or amendments

- D. When a discrepancy arises between the above-mentioned codes, standards or guidelines and the standards contained in this document, it shall be brought to the attention of the Owner immediately for resolution. The more stringent of the two guidelines shall be implemented.

### 1.3 ABBREVIATIONS AND DEFINITIONS

- A. CL - Client (Clemson University)
- B. GC - General Contractor
- C. EC - Electrical Contractor
- D. SC - Security Contractor
- E. TC - Telecommunications Contractor
- F. FA - Fire Alarm Contractor
- G. DH - Door Hardware Contractor

### 1.4 RESPONSIBILITY MATRIX

SCOPE ITEM	BID PKG	FURNISH	INSTALL	SPEC SHEET
SECURITY INFRASTRUCTURE				
EQUIPMENT RACKS AND PATCH PANELS		CL	CL	
COMMUNICATION BACKBONE CABLING		TC	TC	27 13 13
COMMUNICATION HORIZONTAL CABLING		TC	TC	27 15 13
WIRING POWER FOR DOOR ENCLOSURE		EC	EC	26 00 00
DOOR CONTROLLER ENCLOSURE		SC	EC	28 13 00
WIRING DOOR CONTROLLER MODULES IN ENCLOSURE		SC	SC	28 13 00
CONDUITS, BOXES, AND SLEEVES		EC	EC	26 00 00
SECURITY EQUIPMENT				
NETWORK SWITCHES AND UPS UNITS		CL	CL	27 00 00

COMMON WORK RESULTS  
FOR ELECTRONIC SAFETY  
AND SECURITY

28 05 00 - 2

IP CAMERAS		SC	SC	28 13 00
IP CAMERA PATCH CABLE TO CAMERA		TC	SC	27 15 13
IP CAMERA PATCH CABLE TO SWITCH		TC	SC	27 15 13
ELECTRONIC DOOR HARDWARE		DH	DH	08 00 00
ELECTRONIC DOOR HARDWARE CABLING AND TERMINATION		SC	SC	28 05 13
ELECTRONIC DOOR HARDWARE POWER CONTROLLER		SC	SC	28 13 00
TRANSFER HINGE (POWER/PASS-THROUGH)		DH	DH	08 00 00
PROXIMITY CARD READER		SC	SC	28 13 00
PROXIMITY CARD READER CABLING AND TERMINATION		SC	SC	28 05 13
REQUEST TO EXIT DEVICES		SC	SC	28 13 00
REQUEST TO EXIT DEVICE CABLING AND TERMINATION		SC	SC	28 05 13
DOOR CONTACTS		DH	DH	08 00 00
DOOR CONTACT CABLING AND TERMINATION		SC	SC	28 05 13
DOOR CONTROLLER		SC	SC	28 13 00
DOOR CONTROLLER CABLING AND TERMINATION		SC	SC	28 05 13
DOOR CONTROLLER NETWORK CABLING		TC	TC	27 15 13
FIRE ALARM INTERFACE HARDWARE		FA	FA	28 40 00
ACCESS CONTROL TO FIRE ALARM INTERFACE CABLING		SC	SC	28 13 00
SECURITY EQUIPMENT TESTING AND COMMISSIONING		SC	SC	28 00 00
VIDEO SURVEILLANCE SERVERS		CL	CL	28 23 00
VIDEO SURVEILLANCE		CL	CL	28 23 00

STORAGE				
VIDEO SURVEILLANCE LICENSING		SC	SC	28 23 00
ACCESS CONTROL SERVERS		CL	CL	28 13 00
ACCESS CONTROL LICENSING		SC	SC	28 13 00

## 1.5 SYSTEM DESCRIPTION

- A. The physical electronic security system will be the center point for the receiving of security signals from various security sub-systems. The Security Operations Center and various Security monitoring locations will receive signals from the Access Control System (ACS) and Video Surveillance System (VSS). Authorized personnel, based on level of authority, will have access to this information and provide control of these systems.
- B. This contractor shall be responsible for the coordination and providing the interface for all the systems, but also interfacing and coordinating the signals from other systems from Access Control System (ACS), Video Surveillance System (VSS), Fire Alarm (FA), BMS, and other systems in the future
- C. Requirements
  1. Determine hardware, software, and operation requirements to implement a fully functional security system. Owner shall have final approval of all equipment and locations of system.
  2. Install and program all software packages.
  3. Install and configure all hardware and related equipment.
  4. Setup and configure communications between host server and local workstation.
  5. LAN related information shall be provided by owner.
  6. Configure cameras on Server/NVR application and database.
  7. Test systems operation based on a point-by-point inspection.
  8. Perform end-user training.
  9. Participation in system commissioning.

## 1.6 WORK INCLUDES

- A. The Electronic Security Systems contractor shall provide complete full functional systems, including all components and licensing as described within the Project Contact documents.
- B. The Electronic Security Systems contractor shall make final power and data connections to all cameras, power supplies, door hardware, etc.
- C. The Electronic Security Systems contractor shall install all low voltage cabling, excluding balanced twisted pair network cabling, as required.
- D. Network cabling from the local IDF network patch panel to the security device network outlet will be provided by the Telecommunications Contractor. The Electronic Security Systems contractor shall coordinate with the Telecommunications Contractor to insure proper installation. The Electronic Security Systems contractor shall make the final connection to the security device.



- E. Conduit or raceway shall be provided by the Electrical Contractor and is required from devices back to the control and/or network point. The Electronic Security Systems contractor shall coordinate with the Electrical Contractor to insure proper installation.
- F. The Electronic Security Systems contractor shall supply all equipment enclosures required for security equipment.
- G. The Electronic Security Systems contractor shall coordinate all requirements with owner to ensure equipment being supplied will function with existing security devices.
- H. The Electronic Security Systems contractor shall coordinate system requirements with computer hardware being supplied will function as intended.
- I. The Electronic Security Systems contractor shall coordinate all locations and layouts of security system with owner and/or architect.
- J. LAN/WAN network transmission lines shall be provided by owner. Contractor shall be responsible for interfacing network transmission lines with security system.
- K. The Electronic Security Systems contractor shall follow ANSI/TIA standards for all cabling requirements. Coordinate cable type and hardware with owner.

## 1.7 DEFINITIONS

- A. Cable Tray: A support mechanism used to route and support telecommunications and other optical fiber cable. Cable trays may be equipped with side walls or barriers to constrain a cable's horizontal placement or movement.
- B. Category 6A: The balanced twisted-pair specifications characterized by, among other requirements, supports frequencies up to 500 megahertz (MHz).
- C. Communications Pathways: Conduits, cable trays or other supports with the sole purpose of carrying communications cabling. Communications pathways shall not be used by other low-voltage systems, including but not limited to fire alarm, security systems, and or building automation wiring or air/vacuum tubes.
- D. Horizontal Cabling: The cabling between the Telecommunications Room and the Work Area that carries voice, data and/or video signals.
- E. Intermediate Distribution Frame (IDF): An enclosed space designed for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the Backbone and Horizontal Systems. Also frequently referred to as TR.
- F. Plenum-rated: Listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.
- G. Telecommunications Room (TR): An enclosed space designed for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect

between the Backbone and Horizontal Systems. Also frequently referred to as IDF (legacy term).

## 1.8 ABBREVIATIONS AND ACRONYMS

- A. ADA - Americans with Disabilities Act
- B. AHJ - Authority Having Jurisdiction
- C. ANSI - American National Standards Institute
- D. AWG - American Wire Gauge
- E. BICSI - Building Industry Consulting Service International
- F. BPS - Bits per Second
- G. CATV - Community Antenna Television (Cable Television)
- H. CCTV - Closed Circuit Television
- I. CMP - Communications Plenum Cable
- J. CPU - Central Processing Unit
- K. EIA - Electronic Industries Association
- L. FCC - Federal Communications Commission
- M. IEEE - Institute of Electrical and Electronics Engineers
- N. IPS - Images per Second
- O. IT - Information Technology
- P. LAN - Local Area Network
- Q. NEC - National Electrical Code, NFPA 70
- R. NESC - National Electric Safety Code
- S. PoE - Power-over-Ethernet
- T. RAID - Redundant Array of Independent Disks
- U. REX - Request to Exit
- V. SCS - Security Control System
- W. SDRAM - Synchronized Dynamic Random-Access Memory

- X. UL - Underwriters Laboratory
- Y. UTP - Unshielded Twisted Pair
- Z. VLAN - Virtual LAN
- AA. WAN - Wide Area Network

## 1.9 SUBMITTALS

- A. Refer to Division 1 and the General Provisions of the Contract for exact submittal procedures.
- B. Provide a resume of qualifications consisting of a list of three recently completed projects of similar type and size with contact names, telephone numbers and email address for each. Jobs must be representative of the work your proposed team has completed.
- C. Provide resumes of experience for the Project Manager, Lead Engineer, Lead Field Technician, who will be assigned to this project. Provide electronic copies of required certifications for proposed project team.
- D. Work shall not proceed without the Owner and Technology Consultant approval of all submitted items.
- E. Shop drawings shall be submitted in advance of construction to cause no delay in other Contractors' work. Shop drawings shall be submitted at such time to allow the Engineer reasonable time to review shop drawings to make necessary corrections.
- F. It will be assumed that the Contractor has examined the shop drawings and equipment brochures prior to submission and that materials and equipment depicted will readily fit into the construction. Contractor shall also review all completed work related to materials or equipment depicted to ensure that it has been properly installed.
- G. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Contractor, without such review and approval. The Engineer's review of such drawings and brochures shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications unless they have notified the Engineer in writing.
- H. The Division 28 Contractor shall provide for review, without exception prior to material acquisition and installation, multiple copies of the following items, quantity as required by the General Contractor or Construction Manager, as applicable. Specific requirements shall be listed and described within each Division 28 section. Failure to submit required items shall disqualify the bidder.
  - 1. Product Data Sheets (Catalog Cuts)
  - 2. Cabling Diagrams
  - 3. System Schematics
  - 4. Specification Sheets for Test Equipment
  - 5. Bill of Materials
  - 6. Contracting Firm Qualifications and Certifications

7. Installation Team Qualifications by Individual
  8. Current Manufacturer Certifications
- I. The Division 28 Contractor shall provide Coordination Drawings for review, without exception prior to material acquisition and installation for approval to proceed. Coordination Drawings shall consist of floor plans and building sections, drawn to scale. Include Security System Wiring Diagrams and relationships between components.
- J. Provide throughout installation:
1. Product samples, if requested by the Architect, Technology Consultant, General Contractor, or Construction Manager.
  2. Periodic field quality control reports.
  3. Periodic cable test reports.
- K. Provide prior to completion:
1. Actual samples of the component labeling scheme to be applied to cabling components, to be approved by the Architect, Technology Consultant, General Contractor, or Construction Manager.
  2. Draft cable administration drawings, as requested to assist the Owner in the planning process. Drawings will be requested prior to final documentation and as Xerox reproductions of handwritten field copies.
- L. Provide at completion of each construction/testing phase or area, as defined by the General Contractor or Construction Manager:
1. Cable test and certification reports; summary hard copy or full test results on compact disc when requested by the General Contractor or Construction Manager, the Owner's Networking & Telecommunications, or the Technology Consultant. Reports shall be submitted to the requesting party within thirty (30) working days of completion for each phase.
  2. One (1) full size set of final drawings of the actual installation for the Division 28 systems. Drawings shall be given as E size originals and on disc in AutoCAD format.
- M. Provide after the installation is complete
1. One (1) full size set of record drawings of the actual installation for the Division 28 systems. Drawings shall be given as E size originals and on disc in AutoCAD format.
- N. Provide after the installation is complete and two (2) weeks before final acceptance, three (3) bound sets of O&M (Operating and Maintenance) Manuals formatted as defined by Division 1 and within Section 28 00 00. In addition, each copy of the O&M Manual shall include, at minimum, items listed as follows:
1. One (1) copy of each approved submittal.
  2. Cable test and certification reports; summary hard copy and full test results on disc.
    - a. All test data, including documentation of failed tests, the corrective procedures performed, and the results of re-tests are to be documented and submitted in both hard copy and electronically in ASCII format.
    - b. Handwritten test reports shall not be accepted.

- c. All actions required to correct failed tests shall be documented to include the cable identifier, tests that were failed, and actions performed to correct the problem.
3. Instruction manuals including equipment and cable schedules, operating instructions, and manufacturer's instructions.
4. Manufacturer Warranty Certificate.
5. Warranty contacts including but not limited to names, telephone numbers (office and mobile).

#### 1.10 QUALITY ASSURANCE

- A. Comply with all local, state, and federal codes.
- B. All materials furnished shall be new, unused, clean, and free from damage, defects, or corrosion.
- C. Equipment and materials of the same type shall be a product of the same manufacturer throughout unless specifically exempted in advance.
- D. The Contractor shall accept complete responsibility for installation, certification, and support of cabling system. Contractor must show proof the vendor has the certifying manufacturer's support on all these issues with shop drawing submittals.
- E. Only installers trained and certified by the proposed manufacturer shall be allowed to install products. Installers must possess the highest level of certification available by the manufacturer for the specific copper cabling solution being installed.
- F. The Contractor may provide proof of registration/certification of planned installers in bid documents. If not included in the bid documents, the Contractor shall provide a narrative on the levels of registration/certification of their installers within the bid documents. The Contractor shall provide proof of registration/certification for the final list of installers prior to the start of work.
- G. The Owner's Facilities Management and Networking & Telecommunications reserve the right to reject any unregistered or uncertified installers performing work for which they are not registered/certified. The Contractor shall be responsible for any loss of work, delays in schedules, or extra cost because of the use of unregistered/uncertified workers. Additional effort on the part of the Contractor to maintain the installation schedule because of the above-mentioned loss time shall be the Contractor's responsibility and at the Contractor's additional expense.
- H. The Contractor shall provide to the Owner's Campus Facilities Management and Networking & Telecommunications the above required documentation for any worker on this project brought in after the submittal of initial documentation on installers. Owner may periodically check installer identification and registrations/certifications during the installation.

#### 1.11 WARRANTY

- A. Warrant work against faulty material or workmanship in accordance with Division 1 requirements. If the Project is occupied or the systems placed into operation in several phases, then the warranty of each system or piece of equipment shall begin on the date each system or

piece of equipment was placed into satisfactory operation and accepted as such, in writing, by the Owner. The use of building equipment for temporary service, and/or through testing and commissioning of such equipment, does not constitute the beginning of the warranty.

- B. Shall submit, in the bid documents, any additional contractor-specific warranties or guarantees to be offered on the project.
- C. Shall supply all necessary documentation needed to process and record the warranty(s) and to verify the installation solution.
- D. Manufacturer's Warranty
  - 1. Equipment and materials required for installation under these standards shall be the current model and new (less than one (1) year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect for a minimum of one (1) year from the date of project's substantial completion.
  - 2. When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate subcontractor then will have 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or the Owner.
- E. Manufacturer's Extended Warranty
  - 1. All manufacturer extended product warranties shall be afforded to The Owner. A copy of certification by the manufacturer for all products listed in this specification is to be provided.
  - 2. Prior to commencement of the work, the successful bidder shall contact an authorized manufacturer's representative to inform them that this job is being registered under the warranty program.
  - 3. Upon completion of the work, coordinate with the manufacturer the issuance of a full warranty on the entire security system. The Electronic Security Systems contractor at its sole expense will correct any deficiencies determined by the manufacturer.

#### 1.12 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operations and Maintenance Manuals in accordance with Division 1 requirements.
- B. Provide copies of all required test reports.
- C. Provide complete warranty certificates for system and equipment.

#### 1.13 DELIVERY, STORAGE, AND HANDLING

- A. Insofar as possible, deliver items in the manufacturer's original unopened packaging. Where this is not practical, cover items with protective materials to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.
- B. Store items in a clean dry place and protect from damage. Evidence of damage from water or other contaminants will be cause for rejection.

## 1.14 RECORD DRAWINGS

- A. Comply with Division 1 requirements.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. Equipment and materials furnished shall be listed by UL or other nationally accredited testing laboratory where available. When listing is not available for a piece of equipment, it shall be submitted in accordance with Drawings and Specifications and shall be approved by the authorities having jurisdiction
- B. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- C. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.
- D. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.
- E. Alternates may be proposed but shall meet or exceed specifications for the items listed. Acceptance shall be at the sole discretion of the owner.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Contractor shall coordinate with all other trades prior to installation. Meeting with the Electrical and General Contractors to identify pathways and infrastructure space requirements.
- B. The Owner shall not be responsible for delays in work because of shutdowns due to unsafe working practices by Contractors. Delays enforced by the Safety Office caused by unforeseen environmental conditions in the work area may be out of Contractor's control. Contractors shall contact the Owner's primary project manager immediately if delays are incurred for safety reasons.
- C. It shall be the responsibility of the Contractor to secure any parking permits prior to the first day of work on-site.
- D. Work outside of normal operating hours and days shall be coordinated with the Owner's Facilities Management.

### 3.2 FEES AND PERMITS

- A. Obtain and pay for all necessary permits and inspection fees required for this installation.

### 3.3 DIMENSIONS AND DEFINITE LOCATIONS

- A. The Project Drawings depicting work show approximate locations. The exact location of equipment and devices shall be established in the field in accordance with instructions from the owner. Consideration shall be given to construction features, equipment of other trades, and requirements of the equipment proper
- B. The Contractor shall refer to shop drawings and submittal drawings for equipment requiring electrical connections to verify rough-in and connection locations.
- C. Unless specifically stated to the contrary, no drawings by scale shall be used as a dimension to work by. Dimensions noted on the drawings are subject, in each case, to measurements of adjacent or previously completed work and all such measurements necessary shall be taken before undertaking any work dependent upon them.

### 3.4 PROGRESSIVE AND FINAL CLEANING OF PROJECT SITE

- A. During construction, and prior to the Owners acceptance of the building, remove from the premises and dispose of packing material and debris cause by communications work.
- B. Remove dust and debris from interior and exterior of Electronic Security Systems equipment. Clean accessible current carrying equipment prior to being energized.
- C. Contractor shall clean work areas each day and remove debris properly and legally from the Owner's property. Where communications equipment and related materials are installed or stored for use in the project shall be neatly stacked and remain free of debris, cable scraps and accumulated dust from the floor and surfaces of installed communication equipment, and materials. All exits and paths shall be cleaned to prevent dirt from being tracked throughout the facility.
- D. Upon completion of the work, remove excess debris, materials, equipment, tools, and similar items. Leave the premises clean, neat, and orderly.

### 3.5 INSTALLATION

- A. General
- B. Cabling Installation
  - 1. Where cables are supported from building structure, they shall be adequately supported such that the cable will not be damaged by normal building use.
  - 2. Cables shall not be installed or routed in any manner that violates the manufacturer's specifications. Manufacturer's minimum bend radius for static (post installation) cables is 10 times the cable diameter. Manufacturer's minimum bend radius for cables under strain (pulling tension) is 20 times the cable diameter.
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.



4. Install a 5-foot-long service loop on each end of cable. Coil service loop at work area end, maintaining appropriate bend radii. Secure service loop to conduit stub or j-hook above ceiling with Velcro.
5. Unless otherwise specified, terminate cables in accordance with ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard, observing the industry standards for terminating color-coded cables for premises and campus environments.
6. Do not install damaged or defective cable. Installation of damaged cable will not be accepted. Unless otherwise allowed by the Owner, damaged cable shall be removed, and new cable installed at the expense of the Contractor. Damage includes physical damage to the cable and damage that may affect performance. **THE OWNER WILL NOT ACCEPT CABLE OF ANY TYPE UNTIL AFTER IT IS INSTALLED AND PASSES A PHYSICAL INSPECTION AND ALL PERFORMANCE TESTS.**
7. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
8. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports ideally 48 inches but not more than 60 inches apart.
9. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
10. Cables shall not be tied or supported by pipes, ducts, ceiling support wires or other building components which are not part of the communications pathway system.
11. Separation guidelines for routing pathways from power lines and equipment:

Separation of Telecommunications Pathways from Power Lines			
Minimum Separation Distance			
Condition	<2KV	2-5KV	>5KV
Unshielded power lines or electrical equipment in proximity to open or non-metal raceways.	5 inches	12 inches	24 inches
Unshielded power lines in proximity to a grounded metal raceway.	2.5 inches	6 inches	12 inches
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal raceway.	N/A	3 inches	6 inches

### 3.6 CUTTING AND PATCHING

- A. Comply with Division 1 requirements.
- B. Repair or replace routine damage caused by cutting in performance of Work under this Division.
- C. Correct unnecessary damage caused due to installation of electrical Work, brought about through carelessness or lack of coordination.
- D. Holes cut through floor slabs shall be core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs between floors shall be properly sealed, fire proofed and waterproofed.

- E. Holes cut through walls shall be drilled or cut with tools designed for the purpose. All openings, sleeves and holes in walls that extend to underside of floor above shall be properly sealed and fire proofed.
- F. Repairs shall be performed with materials which match existing materials and be installed in accordance with appropriate sections of these Specifications.
- G. Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect.

### 3.7 FIRESTOPPING

- A. Comply with ANSI/TIA-569-C, Annex A, "Fire-stopping."
- B. Comply with BICSI TDMM, Chapter 8 "Fire-stopping."

### 3.8 TESTING

#### A. Cable Testing

- 1. New cable pairs shall be end-to-end tested as follows.
  - a. DC loop resistance
  - b. Wire map
  - c. Continuity to remote end
  - d. Shorts between two or more conductors
  - e. Crossed pairs
  - f. Reversed pairs
  - g. Split pairs
- 2. All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated in the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing. Auto-test settings, provided in the field tester for testing the installed cabling, shall be set to the manufacturer default parameters for the type and characteristics of the cable to be tested.
- 3. Tests shall be performed with connectors and termination completed and in-place.
- 4. Any cable or component not satisfactorily passing the tests as described or failing to meet quality installation standards as described in this specification, shall be repaired, and/or replaced at the Contractor's expense.
- 5. The Contractor shall prepare complete cable test reports for all installed cables for review and approval by the Owner prior to acceptance of the cabling system.

#### B. Final Acceptance Testing

- 1. After testing reports, as-built drawings, and required manuals have been submitted for review, the Contractor shall coordinate a date for Final Acceptance Testing.
- 2. Testing and acceptance of this system will take place in the presence of the owner.
- 3. Acceptance of the system shall require a demonstration of all system components to evaluate their performance and reliability. Prior to this test the system must have been online for a period of sixty (60) days, with an uptime of no less than 99%. Should a major

equipment failure occur, the Contractor shall replace the defective component and continue the testing period. Any items discovered during final inspection which require the contractor's attention, shall be promptly addressed. These items will then be re-inspected by the owner for approval.

4. Upon the completion of acceptable Final Acceptance Testing the Contractor shall submit all finalized project documentation and associated electronic media. Upon approval from the owner, the owner will issue a Letter of Completion to the Contractor indicating the date of such completion. This notice will serve as Client acceptance of this system.

END OF SECTION

SECTION 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the finishing, installation, connection, testing and certification the conductors and cables required for a fully functional for electronic safety and security (ESS) system.

1.2 RELATED WORK

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- C. Section 28 05 00 – COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. Requirements for general requirements that are common to more than one section in Division 28.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- F. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- G. RCDD: Registered Communications Distribution Designer.
- H. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.
- I. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.
- J. UTP: Unshielded twisted pair.

#### 1.4 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
  - 1. Manufacturer's Literature and Data: Showing each cable type and rating.
  - 2. Certificates: Two weeks prior to final inspection, deliver to the Resident Engineer/COTR four copies of the certification that the material is in accordance with the drawings and specifications and diagrams for cable management system.
  - 3. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
    - a. Vertical and horizontal offsets and transitions.
    - b. Clearances for access above and to side 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.
    - e. 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.
  - 4. Wiring Diagrams. Show typical wiring schematics including the following:
    - a. Workstation outlets, jacks, and jack assemblies.
    - b. Patch cords.
    - c. Patch panels.

#### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.
- B. American Society of Testing Material (ASTM):
  - 1. Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- C. Federal Specifications (Fed. Spec.):
  - 1. Cable and Wire, Electrical (Power, Fixed Installation)
- D. National Fire Protection Association (NFPA):
  - 1. National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  - 1. Thermoset-Insulated Wires and Cables
  - 2. Thermoplastic-Insulated Wires and Cables
  - 3. Electrical Grounding and Bonding Equipment

4. Wire Connectors and Soldering Lugs for Use with Copper Conductors
5. Splicing Wire Connectors
6. Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
7. Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
8. Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
9. Fittings for Cable and Conduit
10. Fire Tests of Through-Penetration Fire Stops//

## 1.6 DELIVERY, STORAGE, AND HANDLING

### A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use [optical-fiber flashlight] [or] [optical loss test set] .
2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

## 1.7 PROJECT CONDITIONS

- ### A. Environmental Limitations: Do not deliver or install any cable and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- ### A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars and spools.
3. Straps and other devices.

### B. Conduit and Boxes:

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

### 2.2 BACKBOARDS

- ### A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).
- ### B. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry"

## 2.3 UTP CABLE

- A. Description: 100-ohm, 4-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.
  - 1. Comply with ICEA S-90-661 for mechanical properties.
  - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
  - 3. Comply with TIA/EIA-568-B.2 Category 6a.
  - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM and CMG .
    - b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    - c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    - d. Communications, Limited Purpose: Type CMX.
    - e. Multipurpose: Type MP.
    - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    - g. Multipurpose, Riser Rated: Type MPP, complying with UL 1666.

## 2.4 UTP CABLE HARDWARE

- A. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- B. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25% spare. Integral with connector bodies, including plugs and jacks where indicated.

## 2.5 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CM.
  - 1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Fluorinated ethylene propylene insulation.
  - 3. Unshielded.
  - 4. Fluorinated ethylene propylene jacket.
  - 5. Flame Resistance: NFPA 262, Flame Test.

## 2.6 LOW-VOLTAGE CABLE

### A. Plenum rated Access Control Composite Cable

1. Belden 638AFS
  - a. Element 1 - Card Reader
    - 1) 3 pair, No. 18AWG, stranded
    - 2) PVC Insulation
    - 3) Shielded
    - 4) PVC jacket
    - 5) Flame Resistance: NFPA 262, Flame Test.
  - b. Element 2 - Door Contact
    - 1) 2 conductor, No. 18AWG stranded
    - 2) PVC Insulation
    - 3) Shielded
    - 4) PVC jacket
    - 5) Flame Resistance: NFPA 262, Flame Test.
  - c. Element 3 - Request to exit
    - 1) 4 conductor, No. 18 AWG
    - 2) PVC Insulation
    - 3) Shielded
    - 4) PVC jacket
    - 5) Flame Resistance: NFPA 262, Flame Test.
  - d. Element 4 - Lock Power
    - 1) 4 conductor, No. 16 AWG
    - 2) PVC Insulation
    - 3) Shielded
    - 4) PVC jacket
    - 5) Flame Resistance: NFPA 262, Flame Test.
2. Approved Equal

### B. Proximity Card Reader Cable

1. 6 conductor, No. 18 AWG, stranded or 3 pair, No. 18 AWG, stranded
2. PVC Insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with UL 1581

### C. Plenum-Rated Proximity Card Reader Cable

1. 6 conductor, No. 18 AWG, Stranded or 3 pair, No. 18 AWG stranded
2. PVC Insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with NFPA 262

### D. Door Contact Cable

1. 2 conductor No. 22 AWG, Stranded



2. PVC Insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with UL 1581

E. Plenum Rated Door Contact Cable

1. 2 conductor No. 22 AWG, Stranded
2. PVC Insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with NFPA 262

F. Lock Power Cable

1. 4 conductor No. 16 AWG, Stranded
2. PVC Insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with UL 1581

G. Plenum Rated Lock Power Cable

1. 4 conductor No. 16 AWG Stranded
2. PVC Insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with NFPA 262

H. Request to Exit Cable

1. 4 conductor No. 22 AWG Stranded
2. PVC insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with UL 1581

I. Plenum Rated Request to Exit Cable

1. 4 conductor No. 22 AWG Stranded
2. PVC insulation
3. Shielded
4. PVC Jacket
5. Flame Resistance: Comply with NFPA 262

## 2.7 IDENTIFICATION PRODUCTS

- A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## 2.8 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
- E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- F. Cable will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

## 2.9 WIRE LUBRICATING COMPOUND

- A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.
- B. Shall not be used on wire for isolated type electrical power systems.

## 2.10 FIREPROOFING TAPE

- A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame-retardant elastomer.
- B. The tape shall be self-extinguishing and shall not support combustion. It shall be arc-proof and fireproof.
- C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and be resistant to sunlight and ultraviolet light.
- D. The finished application shall withstand a 200-ampere arc for not less than 30 seconds.
- E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install 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. Pulling Cable:
  - a. Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
  - b. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
  - c. Use ropes made of nonmetallic material for pulling feeders.
  - d. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Resident Engineer/COTR.
  - e. Pull in multiple cables together in a single conduit.

C. Splice cables and wires where necessary only in outlet boxes, junction boxes, or pull boxes.

1. Splices and terminations shall be mechanically and electrically secure.
2. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

D. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.

E. Unless otherwise specified in other sections install wiring and connect to equipment/devices to perform the required functions as shown and specified.

F. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

G. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

H. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.

- I. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.
- J. UTP Cable Installation:
  - 1. Comply with TIA/EIA-568-B.2.
  - 2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- K. Optical Fiber Cable Installation:
  - 1. Comply with TIA/EIA-568-B.3.
  - 2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.
- L. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than [60 inches (1525 mm)] apart.
  - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- M. Installation of Cable Routed Exposed under Raised Floors:
  - 1. Install plenum-rated cable only.
  - 2. Install cabling after the flooring system has been installed in raised floor areas.
  - 3. Coil cable [72 inches (1830 mm)] long shall be neatly coiled not less than [12 inches (300 mm)] in diameter below each feed point.
- N. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
  - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  - 4. Separation between 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 (75 mm).
- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

### 3.2 CONTROL CIRCUIT CONDUCTORS

#### A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

### 3.3 CONNECTIONS

- A. Comply with requirements in Division 28 13 00 Section, ACCESS CONTROL SYSTEMS for connecting, terminating, and identifying wires and cables.
- B. Comply with requirements in Division 28 23 00 Section VIDEO SURVEILLANCE SYSTEMS for connecting, terminating, and identifying wires and cables.

### 3.4 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "PENETRATION FIRESTOPPING."
- B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.5 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 28 Section "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY."

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.
- B. Install a permanent wire marker on each wire at each termination.

- C. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- D. Wire markers shall retain their markings after cleaning.
- E. In each handhole, install embossed brass tags to identify the system served and function.

### 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 UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  - 4. Optical Fiber Cable Tests:
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    - b. Link End-to-End Attenuation Tests:
      - 1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
      - 2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
  - 5. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System."
- D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDDM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.8 EXISTING WIRING

- A. Unless specifically indicated on the plans, existing wiring shall not be reused for the new installation. Only wiring that conforms to the specifications and applicable codes may be reused. If existing wiring does not meet these requirements, existing wiring may not be reused and new wires shall be installed.

END OF SECTION

## SECTION 28 13 00 - ACCESS CONTROL SYSTEM

### 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. The access control system shall be manufactured by Genetec and compatible with the existing campus wide Genetec Control Center . It shall be connected to the existing access control system via a network connection on the existing Clemson University Campus infrastructure VLAN. The access control system shall be connected to a dedicated normal emergency power circuit, and battery backup power shall be provided.
- B. Provide labor, materials, coordination, and equipment necessary to complete the work of this Section, including but not limited to the following:
  - 1. Genetec management software and associated licensing required for a fully functional solution.
  - 2. Door Controller Boards
  - 3. Door Controller Cabinets
  - 4. Door Contacts
  - 5. Request to Exit Devices
- C. Where applicable, installations must include a relay from the fire alarm system located at each access controller to release required doors upon activation of the fire alarm system. The fire alarm relay to be provided and installed by fire protection contractor. The access control interface to the fire alarm relay is to be wired by Contractor and terminated in the controller by the fire protection contractor. Contractor to provide a data outlet for connection of the access control system to the Genetec server.
- D. It is the intent of these specifications to provide a complete workable integrated security system ready for the Client's use as described within the project documentation. Any items not specifically detailed on the drawings or described in the Specifications, but normally required to conform to the intent, are to be considered part of the contract.
- E. These specifications are equipment and performance specifications. Actual installation shall be as indicated on drawings, specifications and/or contained within the manufacturers written installation instructions. Any discrepancies found between the specification, drawings, and manufacturers' installation instructions shall be immediately brought to the attention of the engineer/client in writing at once. Installation and details indicated on the drawings shall govern if they differ from the specifications.



### 1.3 REFERENCES

- A. Design and operation of the system shall conform to the following referenced codes, regulations, and standards as applicable:
  - 1. National Electrical Code (NEC).
  - 2. UL 294 and UL 1076 as required where applicable.
    - a. The system shall be listed by Underwriters Laboratories for UL 294 Access Control Systems, and UL 1076 Proprietary Burglar Alarm systems. PC's and all control panels furnished on the job shall carry the UL 294 and UL 1076 labels as required. Bidders shall provide copies of their UL listing cards or other proof of compliance.
  - 3. Applicable Federal, State, and Local laws, regulations, and codes.
- B. Owner Supplied Specifications
  - 1. Clemson Access Control Policy
- C. When a discrepancy arises between the above-mentioned codes, standards or guidelines and the standards contained in this document, it shall be brought to the attention of the Owner immediately for resolution. The more stringent of the two guidelines shall be implemented.

## PART 2 – PRODUCTS

### 2.1 PRODUCT - GENERAL

- A. Manufacturers:
  - 1. Mercury Security
    - a. LP4502
    - b. LP1502
    - c. MR52-S3
    - d. MR16IN-S3
    - e. MR16OUT-S3
  - 2. HID
    - a. Must be capable of reading the HID Elite iClass SE and Elite SEOS credentials.
  - 3. Life Safety Power
    - a. FP0150/250-2D8P2M8NL4E8M2 - MCLASS Unifed Power System Networked 400W / 12 and 24vdc / 16 Doors / 16 Managed / 16 Aux
- B. Others:
  - 1. Door Contacts
    - a. Vary depending on installation requirements, typical ¾" recessed in most cases
  - 2. Enclosures
    - a. NEMA 1 - 12"x12"x4" – For Network Outlet, Fire Alarm Relay, Duplex Power Receptacle
    - b. NEMA 1 - 6"x6"x3" - For Access Control Junction Box above each door.
- C. Equipment Sole- Source Supplier

1. Clemson has A3, Inc. under contract to provide installation of approve card access systems and components for all new construction. The contractor must review and submit to Clemson for evaluation of the pricing received in accordance with the terms and conditions of that contract. Specific details of each contract must be provided in the specifications; name, contact information, solicitation number, and expiration date. Documentation of the evaluation of this pricing information must be kept in each procurement file for review by Audit and Certification.

## 2.2 READERS – VERIFICATION DEVICES

### A. General:

1. All readers shall be configured with the reader electronics mounted separately on the "secure" side of the door such that only the reader head/keypad and pilot lights are mounted in the reader housing on the "entry" side of the door.

## 2.3 SMARTCARDS

- ### A.
- System shall provide full compatibility with current campus contactless SmartCards read/write technology.

## 2.4 ELECTRIC LOCKSET OR PANIC DEVICE

- ### A.
- Electric lockset/panic device release provided by 080000 door hardware manufacturer. Connections by Division 28 Electronic Security Contractor which includes wiring down the door to the hardware. Interface door electrical lockset/panic device release system to local card access control panel at the local doors terminal cabinet serving that area.

## 2.5 DOOR CONTACTS

- ### A.
- Provide, where shown on drawings, UL listed magnetic flush mounted contacts and magnets. Each contact shall be provided with matching magnet. All contacts shall be hermetically sealed for long term 10,000,000 cycle contact. Switch contacts shall be of the reed blade type with rhodium plating eliminating cold-welding, sticking and resistance build-up. All switches shall be 100 percent factory tested prior to installation. Coordinate with door frame manufacturer and supervised.

## 2.6 WIRE AND CABLE

- ### A.
- Comply with requirements in Division 280513. Size conductors as indicated, but not less than recommended by system manufacturer.
- ### B.
- Furnish and install standard manufacturer's cable assemblies for components, as recommended by the system manufacturer. Include connections for electric lockset/panic device, card reader connections and all required peripheral devices.

## PART 3 - EXECUTION

### 3.1 REPORTABILITY

- A. Clemson University has deployed a centrally managed Physical Access Control System for all university facilities. The system is managed and administered by TigerOne - Division of Student Affairs .

### 3.2 EXAMINATION

- A. Examine conditions, with the installer present, for compliance with requirements and other factors affecting the performance of the security access system work.
- B. Do not proceed until satisfactory conditions have been corrected.

### 3.3 INSTALLATION REQUIREMENTS

- A. All access control devices must be accessible.
- B. Cabinets shall be mounted per provided Clemson details.
- C. Nominal Card Reader Mounting Height: Card readers shall be mounted at the following heights:
  - 1. Interior: 48 inches to center above the finished floor
  - 2. Exterior: 48 inches to center above the finished floor
  - 3. Elevators: 48 inches to center above the finished floor
  - 4. Bollard Mount: 48 inches to center above the walkway
- D. Each wire shall be identified at both ends with the wire designation corresponding to the wire numbers shown on the wiring diagrams.
- E. All exposed wiring within the cabinets, consoles, and terminals shall be formed neatly with wires grouped in bundles using non-metallic, flame-resistant wiring cleats or wire ties.
- F. All ferrous metal work shall be painted, in accordance with the manufacturer's standards.
- G. Coordinate installation of door contacts with door/door hardware manufacturer. All wiring shall be concealed within door-frame and fished/routed within building walls, where not accessible with conduits.

### 3.4 SYSTEM WIRING

- A. Provide system and device wiring as recommended by the manufacturer. All wiring shall be concealed. Route system cabling in J-hooks above ceiling or in crawlspace as required. Install in surface raceway in other areas.

- B. Field wiring must be one piece from source terminal to destination terminal. Splices in field wiring will NOT be allowed.
- C. All wiring splices, junctions, and taps to connect door hardware shall be in serviceable locations; without resorting to removal of door, glass, wall sections, etc.; to facilitate maintenance of the entire application.
- D. Cable, wires and conductors shall be cut so that a minimum of 5 feet length is left for future service on panel and door side.

### 3.5 TESTING AND COMMISSIONING

- A. Commissioning shall be performed by:
  - 1. Clemson approved system integrator - commissions the electronic systems
  - 2. Clemson approved hardware integrator - commissions the doors and hardware functionality
- B. Tech Team representatives from Site Protection shall be an integral part of the commissioning process.
- C. The procedure for testing shall be followed closely in accordance with the Site Protection Pre-Functional and Functional (ATP) tests as supplied by Clemson. Pre-functional testing shall be performed by both the system integrator and the hardware integrator. Functional testing shall be performed by the hardware integrator.

### 3.6 WARRANTY

- A. All equipment furnished under this contract shall be warranted for a period of twelve (12) months from the date of final Engineer/Owner acceptance of the system.
- B. Respond to service requests on-site, if required.
- C. Replace or repair defective components as required.

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Clemson University Video Surveillance Policy

### 1.2 SUMMARY

- A. The Video Surveillance System shall be manufactured by Genetec and compatible with the existing campus wide Video Surveillance System. It shall be connected to the existing Video Surveillance System via a network connection on the existing Clemson University Campus infrastructure VLAN. The Video Surveillance System shall be connected to a dedicated normal emergency power circuit, and battery backup power shall be provided.
- B. Provide labor, materials, coordination, and equipment necessary to complete the work of this Section, including but not limited to the following:
  - 1. Genetec management software and associated licensing required for a fully functional solution
  - 2. Network video cameras
  - 3. Surge protection devices
- C. It is the intent of these specifications to provide a complete workable integrated security system ready for the Client's use as described within the project documentation. Any items not specifically detailed on the drawings or described in the Specifications, but normally required to conform to the intent, are to be considered as part of the Contract.
- D. These specifications are equipment and performance specifications. Actual installation shall be as indicated on drawings, specifications and/or contained within the manufacturers written installation instructions. Any discrepancies found between the specification, drawings and manufacturers' installation instructions shall be immediately brought to the attention of engineer/Client in writing at once. Installation and details indicated on the drawings shall govern if they differ from the specifications.

### 1.3 REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Related Documents and Sections
  - 1. Division 01 – General Requirements
  - 2. Division 26 – Electrical
  - 3. Division 27 - Communications

C. The following codes, associations, acts and agencies, as required by law:

1. American National Standards Institute/Electronic Industries Association/Telecommunication Industries Association (ANSI/EIA/TIA)
2. Federal Communications Commission (FCC)
3. National Fire Protection Association (NFPA)
4. NFPA-70, 2011 (National Electric Code)
5. National Electrical Safety Code (NESC)
6. National Electrical Manufacturers Association (NEMA)
7. Occupational Safety and Health Administration (OSHA)
8. UL Standard for Safety
9. International Building Code
10. International Fire Code
11. Any additional applicable local codes or amendments

D. When a discrepancy arises between the above-mentioned codes, standards or guidelines and the standards contained in this document, it shall be brought to the attention of the Owner immediately for resolution. The more stringent of the two guidelines shall be implemented.

## 1.4 SYSTEM DESCRIPTION

### A. Overview

1. The video surveillance system shall have the following components and capabilities.
  - a. Video surveillance systems shall include digital recording, multiplexing and Internet-based server capabilities.
  - b. Exterior cameras shall be both environmentally protected and heated. Provisions for preventing snow and ice build-up shall be included. Daytime and nighttime cameras that are equipped with an electronic auto iris are required for all exterior applications if analog, day/night if IP.
  - c. Interior cameras shall be premium grade and provide high resolution color images. Applications that have variable lighting conditions shall require an auto iris lens on each interior camera.
2. Cameras will be served by Owner provided network switches located in telecommunication rooms and utilize Owner provided LAN to communicate with the network recording servers for video storage.
3. Cabling (PoE network connectivity) for the network cameras shall follow requirements as detailed within the Division 27000 specifications. Network cabling will be provided by the Telecommunications Contractor and will be terminated at the camera location utilizing an 8 position 8 contact (8P8C) modular connector. Factory manufactured and certified patch cords for use as the final camera connection will be furnished by the Telecommunication Contractor and installed by the Electronic Security Systems contractor. Additional cable requirements (power, control, etc.) shall be provided by the Electronic Security Systems contractor.
4. The Electronic Security Systems contractor shall be responsible for the coordination and providing the interface for all the systems, but also interfacing and coordinating the signals from other systems including the Access Control System, Emergency Phone System, and Other Systems in the Future

### B. Scope of Work includes, but is not limited to, the following

1. Provide video management license fees to support the cameras and security devices shown on the project drawings.
2. Provide network fixed/PTZ/Fisheye cameras as shown on project drawings including all required mounting hardware.

## 1.5 SUBMITTALS

- A. Refer to Division 1 and the General Provisions of the Contract for exact submittal procedures.
- B. It will be assumed that the Contractor has examined the shop drawings and equipment brochures prior to submission and that materials and equipment depicted will readily fit into the construction. Contractor shall also review all completed work related to materials or equipment depicted to ensure that it has been properly installed.
- C. Provide Storage Calculation for each camera providing images per second, frame rate, video compression used, and days of storage

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.
- C. Unless otherwise noted, all materials and equipment shall be new, of the type, capacity, and quality specified and free from defects. Material shall bear the label of or be listed by the Underwriters' Laboratories (U.L.) unless of a type for which label or listing service is not provided.

### 2.2 VIDEO SURVEILLANCE SOFTWARE

- A. Application: Software-that provides remote video monitoring, recording, and event management functionality without being dependent on specific hardware.
- B. Video Management Software:
  1. Genetec
- C. Licensing
  1. Contractor shall provide all licensing as required to support the streaming and recording of cameras furnished under this contract on to the existing Video Management platform.

### 2.3 NETWORK VIDEO RECORDER SERVERS

- A. Application: Dedicated servers for network video management and recording.

B. Digital Video Recording Servers

1. Provided by Client
2. Programmed by Client for 30 days of storage retention. Please add 20% buffer for future expansion.

2.4 EXTERIOR FISHEYE CAMERA

A. Application: 12MP 360 Degree Lens

B. Acceptable Manufactures

1. Axis Communications M4318-PLVE
2. No substitutions

C. Camera

1. Imager
  - a. Image Sensor: 1/2.3" progressive scan RGB CMOS
  - b. Lens
    - 1) Focal length: 1.2 mm, F2.2
    - 2) Horizontal field of view: 182°
    - 3) Vertical field of view: 182°
    - 4) Fixed iris, IR corrected, fixed focus
  - c. Illumination
    - 1) Color: 0.19 lux at 50 IRE, F2.2
    - 2) B/W: 0.04 lux at 50 IRE, F2.2
    - 3) 0 lux with IR illumination on
  - d. Shutter Speed: 1/8100 s to 0.5 s
2. Video
  - a. Video Compression:
    - 1) H.264 (MPEG-4 Part 10/AVC) Baseline, Main, and High Profiles
    - 2) H.265 (MPEG-H Part 2/HEVC) Main Profile
    - 3) Motion JPEG
  - b. Resolution
    - 1) Overview: 2992x2992 to 160x160
    - 2) Panorama: 3584x1344 to 192x72
    - 3) Double panorama: 3584x2688 to 512x288
    - 4) Quad View: 3584x2688 to 384x288
    - 5) View Area 1-4: 2048x1536 to 256x144
    - 6) Corner right and left: 3200x1200 to 192x72
    - 7) Double corner: 2880x2880 to 384x288
    - 8) Corridor: 2560x1920 to 256x144
  - c. Frame Rate
    - 1) 360 overview only up to 2992x2992 without WDR: 25/30 fps @50/60 Hz
    - 2) 360 overview and dewarped views up to max resolution with WDR: up to 25/20 fps @50/60 Hz
  - d. Streaming
    - 1) Multiple, individually configurable streams in H.264, H.265 and Motion JPEG
    - 2) Axis Zipstream technology in H.264 and H.265



- 3) Controllable frame rate and bandwidth
- 4) VBR/ABR/MBR H.264/H.265
- 5) Video streaming indicator
- 3. Settings
  - a. Saturation, contrast, brightness, sharpness, local contrast, tone mapping, white balance, day/night threshold, exposure mode, exposure zones, compression, mirroring, dynamic text and image overlay, polygon privacy mask
- 4. Network
  - a. Supported protocols: IPv4, IPv6, USGv6, ICMPv4/ICMPv6, HTTP, HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP, TCP, UDP, IGMPv1/v2/v3, RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT v3.1.1, Syslog, Link-Local, address (ZeroConf), IEEE 802.1X (EAP-TLS), IEEE 802.1AR
- 5. Security
  - a. Edge Security
    - 1) Software
      - (a) Signed firmware, brute force delay protection, digest authentication, password protection, AES-XTS-Plain64 256bit, SD card encryption
    - 2) Hardware
      - (a) Axis Edge Vault cybersecurity platform Secure element (CC EAL 6+), system-on-chip security (TEE), Axis device ID, secure keystore, signed video, secure boot, encrypted filesystem (AES-XTS-Plain64 256bit)
  - b. Network Security
    - 1) IEEE 802.1X (EAP-TLS), IEEE 802.1AR, HTTPS/HSTS, TLS v1.2/v1.3, Network Time Security (NTS), X.509 Certificate PKI, IP address filtering
- 6. General
  - a. Casing: IP66-, NEMA 4X- and IK10 rated, Polycarbonate hard-coated dome, Aluminum
  - b. Power: Power over Ethernet (PoE) IEEE 802.3af/802.3at Type 1 Class 3 Typical 6.4W, max 12.95 W
  - c. Operating Conditions: -40 °C to 50 °C (-40 °F to 122 °F) Maximum temperature: 55° C (131°F) Start up Temperature -30 °C to 50 °C (-22 °F to 122 °F) Humidity 10–100% RH (condensing)

## 2.5 EXTERIOR MULTI-SENSOR CAMERA

- A. Application: Multi-sensor IP-cameras capable of providing a minimum 4 x Quad HD resolution in an exterior housing.
- B. Acceptable Manufacturers
  - 1. Axis Communications P3719-PLE
  - 2. No substitutions
- C. Camera
  - 1. Imager
    - a. Image Sensor: 4 x 1/2.5" progressive scan RGB CMOS
    - b. Lens: Varifocal, 3–6 mm, F1.8–2.6, 4 x 1440p capture mode: Horizontal field of view: 101°–49° Vertical field of view: 54°–29° Diagonal field of view: 116°–58°

- Motorized focus, motorized zoom
- c. Illumination: Color: 0.20 lux at 50 IRE F1.8, B/W: 0.04 lux at 50 IRE F1.8, 0 lux with IR illumination on
- d. Shutter speed: 1/66500 s to 1/5 s with 50/60 Hz
- 2. Video
  - a. Video Compression
    - 1) H.264 (MPEG-4 Part 10/AVC) Main and High Profiles
    - 2) H.265 (MPEG-H Part 2)
  - b. Resolution: 4 x 2560x1440 (4 x QHD 1440p) to 4x 640x360
  - c. Frame rate: Up to 25/30 fps (50/60 Hz)
  - d. Streaming: Multiple, individually configurable streams in H.264 and H.265, Axis Zipstream technology in H.264 and H.265, Controllable frame rate and bandwidth, VBR/ABR/MBR H.264
- 3. Settings: Saturation, contrast, brightness, sharpness, WDR, white balance, exposure control, rotation: 0°, 90°, 180°, 270° including Corridor Format, dynamic text and image overlay, polygon privacy mask, compression
- 4. Network
  - a. Security: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X (EAP-TLS) network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware
  - b. Supported protocols: IPv4, IPv6, USGv6, HTTP, HTTPS, TLS, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, SFTP, TCP, UDP, IGMPv1/v2/v3, RTCP, ICMP, DHCP, v4/v6 ARP, SSH, LLDP, CDP MQTT, MQTT v3.1.1, Syslog, Link-Local address (ZeroConf)
- 5. General:
  - a. Casing: IP66-, IP67-, NEMA 4X-rated, IK09 impact-resistant, aluminum and plastic casing with polycarbonate hard-coated dome, sunshield (PC/ASA)
  - b. Camera Power: Power over Ethernet (PoE) IEEE 802.3at Type 2 Class 4, IR illumination on: class 4, typical 16.3 W, max 25.5 W, IR illumination off: class 3, typical 10.7 W, max 25.5 W
  - c. IR illumination: Four individually controllable IR with power-efficient, long-life 850 nm IR LEDs, Range of reach 15 m (50 ft) or more depending on the scene
  - d. Operating Conditions: -30 °C to 50°C (-22 °F to 122 °F) Humidity 10–100% RH (condensing) Maximum temperature according to NEMA TS 2 (2.2.7): 74 °C (165 °F)

## 2.6 EXTERIOR 5MP VARIFOCAL CAMERA

- A. Application: 5MP 3-8mm Lens Dome Camera
- B. Acceptable Manufacturers
  - 1. Axis Communications P3267-LVE
  - 2. No substitutions
- C. Camera
  - 1. Imager
    - a. 1/2.7" progressive scan RGB CMOS

- b. Lens: Varifocal, 3–8 mm, F1.3, Horizontal field of view: 104°–40°, Vertical field of view: 74°–29°
- c. Illumination: Color: 0.13 lux at 50 IRE, F1.3, B/W: 0 lux at 50 IRE, F1.3
- d. Shutter Speed: 1/33500 s to 1/5 s
- 2. Video
  - a. Video Compression
    - 1) H.264 (MPEG-4 Part 10/AVC) Baseline, Main, and High Profiles
    - 2) H.265 (MPEG-H Part 2/HEVC) Main Profile
    - 3) Motion JPEG
  - b. Resolution
    - 1) 2592x1944 to 160x90
  - c. Frame Rate
    - 1) 25/30 fps with power line frequency 50/60 Hz
  - d. Streaming
    - 1) Multiple, individually configurable streams in H.264, H.265, and Motion JPEG
    - 2) Axis Zipstream technology in H.264 and H.265
    - 3) Controllable frame rate and bandwidth
    - 4) VBR/ABR/MBR H.264/H.265
- 3. Settings
  - a. Saturation, contrast, brightness, sharpness, Forensic WDR: up to 120 dB depending on scene, white balance, day/night threshold, local contrast, tone mapping, exposure mode, exposure zones, defogging, barrel distortion correction, compression, rotation: 0°, 90°, 180°, 270° including Corridor Format, mirroring, dynamic, text and image overlay, privacy masks, polygon privacy mask
- 4. Network
  - a. Security: IP address filtering, HTTPS encryption, IEEE 802.1x (EAP-TLS), network access control, user access log, centralized certificate management
  - b. Supported protocols: IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTCP, RTP, SRTP/RTSPS, TCP, UDP, IGMPv1/v2/v3, DHCPv4/v6, ARP, SSH, SIP, LLDP, CDP, MQTT v3.1.1, Secure syslog (RFC 3164/5424, UDP/TCP/TLS), Link-Local address (ZeroConf)
- 5. General
  - a. Casing: IP66-, NEMA 4X- and IK10-rated, Polycarbonate hard coated dome, Polycarbonate casing and weathershield
  - b. Power: Power over Ethernet (PoE) IEEE 802.3af/802.3at Type 1 Class 3 Typical 6.4 W, max 12.1 W
  - c. Operating Conditions: -40 °C to 50 °C (-40 °F to 122 °F), Maximum temperature according to NEMA TS 2 (2.2.7): 74 °C (165 °F), Start-up temperature: -30 °C to 50 °C (-22 °F to 122 °F), Humidity 10–100% RH (condensing)

## 2.7 INTERIOR FISHEYE CAMERA

A. Application: 12MP 360 Degree Lens

B. Acceptable Manufacturers

- 1. Axis Communications M3068-P
- 2. No substitutions

### C. Camera

1. Imager
  - a. Imager Sensor: 12MP (4000x3000), 1/1.7" progressive scan RGB CMOS
  - b. Lens: 1.65 mm, F2.8, Horizontal field of view: 185°, Vertical field of view: 185°, Fixed iris, IR corrected
  - c. Illumination: Color: 0.32 lux at 50 IRE F2.8, B/W: 0.06 lux at 50 IRE F2.8
  - d. Shutter Speed: 1/22000s to 1s with 50Hz
2. Video
  - a. Video Compression
    - 1) H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles
    - 2) H.265 (MPEG-H Part 2/HEVC) Main Profile
    - 3) Motion JPEG
  - b. Resolution
    - 1) Overview: 2880x2880 to 160x160 (1:1)
    - 2) Panorama: 3840x2160 to 192x72 (8:3, 16:9, or 32:9)
    - 3) Double panorama: 3584x2688 to 384x288 (4:3 or 16:9)
    - 4) Quad View: 3584x2688 to 384x288 (4:3 or 16:9)
    - 5) View area 1-4: 2048x1536 to 256x144 (4:3 to 16:9)
    - 6) Corner left/right: 3200x1600 to 192x72 (2:1 or 8:3)
    - 7) Double corner: 2880x2880 to 384x288 (1:1 or 4:3)
    - 8) Corridor: 2560x1920 to 256x144 (4:3 or 16:9)
  - c. Frame Rate
    - 1) 360° overview only, up to 2880x2880 without WDR: 25/30 fps @ 50/60Hz
    - 2) 360° overview and 4 dewarped views with WDR: up to 12.5/15 fps @ 50/60Hz
  - d. Streaming
    - 1) Multiple, individually configurable streams in H.264, H.265 and Motion JPEG
    - 2) Axis Zipstream technology in H.264 and H.265
    - 3) Controllable frame rate and bandwidth
    - 4) VBR/ABR/MBR H.264/H.265
    - 5) Low latency mode
3. Settings
  - a. Compression, color saturation, brightness, sharpness, contrast, local contrast, white balance, day/night threshold, tone mapping, exposure control (including automatic gain control), exposure zones, Forensic WDR: up to 120 dB depending on scene, fine tuning of low-light behavior, dynamic text and image overlay, mirroring, digital roll, polygon privacy masks
4. Network
  - a. Security: IP address filtering, HTTPS encryption, IEEE 802.1X (EAP-TLS) network access control, user access log, centralized certificate management
  - b. Network Protocols: IPv4, IPv6, USGv6, ICMPv4/ICMPv6, HTTP, HTTP/2, HTTPS, TZLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP, IGMPv1/v2/v3, RTCP, ICMP, DHCPv4/v6, ARP, SSH, LLDP, CDP, MQTT v3.1.1, Syslog, Link-local address (Zero Conf)
5. General
  - a. Casing: Polycarbonate and aluminum casing, encapsulated electronics
  - b. Power: Power over Ethernet (PoE) IEEE 802.3af/802.3at Type 1 Class 2 Typical 3.7 W
  - c. Operating Conditions: 0° C to 40° C (32° F to 133° F), Humidity 10-85% RH (non-condensing)

## 2.8 CAMERA SURGE PROTECTION DEVICES

- A. Application: Protects circuits and devices that use PoE connections.
- B. Provide surge protection devices for all exterior cameras.
- C. Surge Protection Devices
  - 1. Features
    - a. Protects power, video, and data on network-based security cameras.
    - b. Supports GbE without signal degradation.
    - c. Compliant with IEEE 802.3af and 802.3at for PoE and High PoE
  - 2. General
    - a. Connectors: RJ45 connection with external grounding screw
    - b. Data rate: Gigabit Ethernet
    - c. Max Continuous Current: 1.5 Amps
    - d. Dissipation: 3,000W
    - e. Protection Mode: Line-Ground
- D. Manufactures
  - 1. Ditek
    - a. #DTK-MRJPOE, single channel surge protection device
    - b. #DTK-RM12NETS, 12-channel surge protection device
  - 2. Approved Equal

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Contractor shall coordinate with all other trades prior to installation. Meeting with the Electrical Communications, and General Contractors to identify pathways and infrastructure space requirements.
- B. Install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- C. Visit the site and verify that site conditions are in agreement with the design package. Report all changes to the site or conditions that will affect performance of the system to the Owner in a report. The Contractor shall not take any corrective action without written permission from the Owner and Owner.
- D. The Contractor shall perform a field survey and furnish a report to the Owner as part of the site survey report. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Owner equipment.
- E. Verify that all surfaces and areas are ready to receive work.

- F. Verify field measurements as shown on drawings and as instructed by manufacturer.
- G. Verify that required utilities are available, in proper location, and ready for use.

### 3.2 DIMENSIONS AND DEFINITE LOCATIONS

- A. The Project Drawings depicting work show approximate locations. The exact location of equipment and devices shall be established in the field in accordance with instructions from the owner. Consideration shall be given to construction features, equipment of other trades, and requirements of the equipment proper
- B. The Contractor shall refer to shop drawings and submittal drawings for equipment requiring electrical connections to verify rough-in and connection locations.
- C. Unless specifically stated to the contrary, no drawings by scale shall be used as a dimension to work by. Dimensions noted on the drawings are subject, in each case, to measurements of adjacent or previously completed work and all such measurements necessary shall be taken before undertaking any work dependent upon them.

### 3.3 INSTALLATION

#### A. General

- 1. Install the video surveillance system related equipment as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each device for conditions encountered at the site; connect signal lines and AC power to equipment.
- 2. Ensure that:
  - a. All applicable statutes, ordinances, regulations, license requirements and codes are fully complied with.
  - b. All required permits are obtained.
  - c. All required inspections are conducted.
  - d. All necessary certificates are issues, obtained, and delivered to the Owner.
  - e. All equipment installations and mounting are in strict accordance with requirements for applicable seismic classification.

#### B. Video Management Software

- 1. Coordinate with Owner's IT and Security representatives to set the following criteria:
  - a. Administrator and operator passwords
  - b. Camera and video device nomenclature
  - c. Maximum bitrate and bandwidth throttle, if any
    - 1) Bit rate assumptions
      - (a) 2MP Camera 2-4Mbps per lens
      - (b) 5MP Camera 5-8Mbps per lens
      - (c) 6MP Camera 6-9Mbps per lens
      - (d) 8 or 12MP Camera 8-14Mbps per lens
  - d. Camera groups, salvos, and operator views
  - e. PTZ camera presets

- f. Mapping features and criteria for a fully interactive graphical display of each floor plan
- g. Alarm events and integration into the access control system and other subsystems

C. Network Video Recorders

- 1. Rack mount servers and storage arrays in the Server room. Coordinate with Owner's IT and Security representatives for exact location.

D. Network Cameras

- 1. Provide flush ceiling mount kit for fixed network cameras within interior accessible ceiling space. Install camera body above ceiling line so only lower polycarbonate dome and trim ring is exposed.
- 2. Provide outdoor rated housings and mounts for exterior cameras.
- 3. Prior to installation, coordinate with electrical contractor to confirm exact placement of cameras for conduit and rough-in requirements.
- 4. Field determine exact placement of cameras installed in interior accessible ceiling to ensure complete coverage of targeted area.
- 5. Adjust the wide dynamic range, gain control, and noise reduction settings on each camera as required to provide clear and crisp video images.

### 3.4 PROGRESSIVE AND FINAL CLEANING OF PROJECT SITE

- A. During construction, and prior to the Owners acceptance of the building, remove from the premises and dispose of packing material and debris cause by communications work.
- B. Remove dust and debris from interior and exterior of telecommunications equipment. Clean accessible current carrying equipment prior to being energized.
- C. Contractor shall clean work areas each day and remove debris properly and legally from the Owner's property. Where communications equipment and related materials are installed or stored for use in the project shall be neatly stacked and remain free of debris, cable scraps and accumulated dust from the floor and surfaces of installed communication equipment, and materials. All exits and paths shall be cleaned to prevent dirt from being tracked throughout the facility.
- D. Upon completion of the work, remove excess debris, materials, equipment, tools, and similar items. Leave the premises clean, neat, and orderly.

### 3.5 CAMERA SURGE PROTECTION

- A. Connect incoming horizontal UTP cabling in the IN connector. Connect the camera's UTP patch cable to the OUT connector to be protected.
- B. Use common ground per device to eliminate the possibility of a differential in ground potentials.

### 3.6 TESTING

#### A. General

1. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Written permission shall be obtained from the Owner before proceeding with the next phase of testing. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of each phase of testing prior to Owner approval of the test.
2. Coordinate testing requirements with the General Contractor and provide specific information on pre-acceptance and final acceptance testing activities so that they can be entered into the overall construction schedule.

#### B. Cable Testing

1. All cables and termination hardware shall be 100% tested for defects in the installation and the materials used to verify performance under installed conditions. All conductors of each installed cable and system component shall be verified usable by the contractor.
2. Testing for the horizontal structured cabling serving the video surveillance system provided by under Section 271513 - Communications Horizontal Copper Cabling.

#### C. Pre-Acceptance Testing

1. The Contractor shall perform a 100% pre-acceptance test to verify operation of the video surveillance system prior to the final acceptance test with the Owner.
2. Pre-Acceptance Testing activities shall not occur until Contractor has ensured that all punch list items have been remedied. If conditions exist that may cause degradation or interference with any security device, the Contractor shall inform the Owner.
3. The pre-acceptance testing shall, as a minimum, include:
  - a. Verification that all signal or control cabling under this contract has been installed, tested, and approved as specified.
  - b. Verification that cameras are properly installed and provide clear, crisp images in the specified format and resolution.
  - c. Verification that current recording configuration provides the minimum required storage (i.e., 30 days, etc.).
  - d. Verification that client software is able to view live video and recorded video. Verify graphical mapping and alarm management screens.
  - e. Verify integration with specified access control system for automatic camera call-up on alarm with proper alarm/event recording parameters.
4. Document the results of the pre-acceptance testing using approved test forms. Report shall indicate the system has been properly calibrated, tested, and is ready to begin final acceptance testing with the Owner.

#### D. Acceptance Testing

1. Upon successful completion of Pre-Acceptance Testing, the Contractor shall demonstrate to the Owner that the completed video surveillance system complies with the contractor requirements. Acceptance Testing shall not commence until receipt of approved Pre-Acceptance Testing activities based on the Contractor's written report.



2. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown.
3. The Owner may terminate Acceptance Testing at any time when the system fails to perform as specified. Upon termination of testing by the Owner or by the Contractor, the Contractor shall submit a report outlining the required repairs to the Owner then commence system repairs upon direction by the Owner. Upon successful completion of the Acceptance Testing, the Contractor shall deliver test reports and other documentation as specified to the Owner.

END OF SECTION

## SECTION 28 31 00 - FIRE DETECTION AND ALARM

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes fire alarm control panels, manual fire alarm stations, automatic smoke and heat detectors, fire alarm signaling appliances, and auxiliary fire alarm equipment and power and signal wire and cable.

#### 1.2 REFERENCES

- A. National Fire Protection Association:
  - 1. NFPA 72 - National Fire Alarm Code.
  - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

#### 1.3 SYSTEM DESCRIPTION

- A. General: Provide a complete, non-coded, addressable microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.
- B. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- C. Wiring/Signal Transmission:
  - 1. Transmission shall be hard-wired, addressable signal transmission, dedicated to fire alarm service only.
  - 2. System connections for initiating, signaling line circuits and notification appliance circuits shall be Class B.
  - 3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- D. Required Functions: The following are required system functions and operating features:
  - 1. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided under another contract.
  - 2. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the location and type of device.
  - 3. General Alarm: A system general alarm shall include:
    - a. Indication of alarm condition at the FACP and the annunciator(s).
    - b. Identification of the device that is the source of the alarm at the FACP and the annunciator(s).

- c. Operation of audible and visible notification devices throughout the building until silenced at FACP.
- d. Unlocking designated doors.
- e. Shutting down supply and return fans serving zone where alarm is initiated.
- f. Notifying the local fire department.
- g. Initiation of elevator recall in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated.
- 4. Supervisory Operations: Upon activation of a supervisory device such as tamper switch, the system shall operate as follows:
  - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
  - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
  - c. Record the event in the FACP historical log.
  - d. Transmission of supervisory signal to remote central station.
  - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
- 5. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible and visible alarm signals shall cease operation.
- 6. System Reset:
  - a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
  - b. Should an alarm condition continue, the system will remain in an alarmed state.
- 7. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
- 8. WALKTEST: The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
  - a. The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
  - b. Control relay functions associated to one of the 8 testing groups shall be bypassed.
  - c. The control unit shall indicate a trouble condition.
  - d. The alarm activation of any initiation device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
  - e. The unit shall automatically reset itself after signaling is complete.

- f. Any opening of an initiating or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
- E. Analog Smoke Sensors:
  - 1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
  - 2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
  - 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
  - 4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.
  - 5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system. If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported [to the Central Monitoring Station]. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
  - 6. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
  - 7. Magnet test of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.
- F. Alarm Notification: By Visual Strobes and Speakers in areas as indicated on drawings.
  - 1. Notification device locations are recommendations based on room type, sizes, finishes and other components.
  - 2. Contractor is responsible for device layout, strobe intensity, and speaker volume to provide a fully compliant system with required sound levels and intelligibility of message. Provide audibility and intelligibility calculations for voice notification system.

- G. Fire Suppression Monitoring:
  - 1. Water flow: Activation of water flow switch shall initiate general alarm operations.
  - 2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
  - 3. Pressure switch in dry pipe systems.
  - 4. Provide 24-volt connection from fire alarm panel to sprinkler system alarm bell furnished under Division 21.
- H. Power Requirements
  - 1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
  - 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period as defined under Emergency Power Supply in this Specification. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
  - 3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
  - 4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
  - 5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
  - 6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
  - 7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
  - 8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

#### 1.4 SUBMITTALS

- A. Shop Drawings: Prepare on "E-Size" (30x42) sheets.
  - 1. Indicate system wiring diagrams
  - 2. Floor plans with each device location, conduit routing and wiring connections.
  - 3. Annunciator layout
  - 4. Battery calculations.
  - 5. Voltage Drop Calculations
  - 6. System riser diagram
  - 7. Audibility Calculations
  - 8. List of all devices on each signaling line circuit, with spare capacity indicated.
  - 9. Clear and concise description of operation, with input/output matrix.
- B. Product Data: Submit catalog data showing electrical characteristics and connection requirements.
- C. Warranty

- D. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.
- E. Inspection and Test Reports:
  - 1. Submit inspection and test plan prior to closeout demonstration
  - 2. Submit documentation of satisfactory inspections and tests.
  - 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- F. Test Reports: Indicate procedures and results for specified field testing and inspection.
- G. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of fire alarm equipment.
- B. Operation and Maintenance Data: Submit manufacturer's standard operating and maintenance instructions.

#### 1.6 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.
- B. Installer Qualifications: NICET Level IV certified fire alarm technician.
  - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
- C. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.
- D. Maintain one copy of contract documents and shop drawings on site.

#### 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience and with service facilities within 50 miles of project.
- B. Installer: Certified fire alarm installer with service facilities within 50 miles of Project.
- C. Design fire alarm under direct supervision of NICET Level IV technician.

## 1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of fire alarm equipment for one year from Date of Substantial Completion.

## 1.9 MAINTENANCE MATERIALS

- A. Furnish six keys of each type.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by JCI/Tyco/SimplexGrinnell and represent the base bid for the equipment. Clemson University's current contract number with JCI/Tyco/Simplex Grinnell is #94261913.

### 2.2 CONTROL PANEL

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. Product Description: Existing JCI / Simplex 4100U shall be removed by fire alarm system contractor and upgraded to a JCI / Simplex 4100ES control panel. Upgraded fire alarm control panel shall be installed in new location shown on plans.
- C. The following hardware shall be provided:
  - 1. Power Limited base panel with semi-flush cabinet and door, 120 VAC input power.
  - 2. All battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.
  - 3. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
  - 4. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
- D. Initiating Device Circuits: Supervised zone module with alarm and trouble indication; occurrence of single ground or open condition places circuit in trouble mode but does not disable circuit from initiating alarm.
- E. Indicating Appliance Circuits: Supervised march time signal module, sufficient for signal devices connected to system; occurrence of single ground or open condition places circuit in trouble mode but does not disable circuit from signaling alarm.
- F. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

## 2.3 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 5 minutes.

## 2.4 MANUAL FIRE ALARM STATIONS

- A. Product Description: Manual double-action station. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- B. Mounting: Semi-Flush.
- C. Backbox: Manufacturer's standard. Surface mount applications shall utilize manufacturer's surface mount box. Do not mount on a standard outlet box.

## 2.5 SPOT HEAT DETECTOR

- A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F per minute.
- D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

## 2.6 CEILING SMOKE DETECTOR

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
  - 1. Factory Nameplate: Serial number and type identification.
  - 2. Operating Voltage: 24 VDC, nominal.
  - 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
  - 4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head



once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.

5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
9. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
10. Removal of the sensor head for cleaning shall not require the setting of addresses.

B. Bases: Relay output, isolator bases shall be supported alternatives to the standard base.

## 2.7 MULTI – SENSORS

- A. Addressable sensor with multiple sensors integral to device for detecting smoke, heat and carbon monoxide (CO). Heat and smoke criteria shall be as defined above for individual detectors.

## 2.8 DUCT-MOUNTED SMOKE DETECTOR

- A. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
  2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
  3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
  4. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
  5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.

6. Duct Housing shall provide a magnetic test area and Red sensor status LED.
7. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
8. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.
9. Where indicated provide a NEMA 4X weatherproof duct housing enclosure shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.

## 2.9 ALARM NOTIFICATION APPLIANCES

- A. Horn: Listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.
- B. Visible/Only: Listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.
- C. Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:
  1. Synchronized Strobe with Horn on steady
  2. Synchronized Strobe with Temporal Code Pattern on Horn
  3. Synchronized Strobe with March Time cadence on Horn
  4. Synchronized Strobe firing to NAC sync signal with Horn silenced
- D. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.
  1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC using and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.

2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
3. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
4. The S/V installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension
5. Test the lines and automatically restore the connection.

E. All Notification appliances shall be white and labeled "ALERT". "FIRE" is **not** allowed.

## 2.10 WIRE AND CABLE

- A. Fire Alarm wire and cabling shall be installed in conduit.
- B. Contractor shall coordinate conduit requirements with Fire Alarm System installer prior to bid.

## 2.11 SURGE PROTECTION DEVICE (Line Voltage)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide DITEK Surge Protection; Model DTK-120X12 or DTK-DF120S1 or comparable product by one of the following:
  1. Advanced Protection Technologies Inc. (APT)
  2. Liebert; a brand of Vertiv
- B. Provide SPDs on nominal 120 V ac electrical circuits that supply power to main Fire-Alarm Control Panel (FACP), booster power supply units, and amplifiers.
  1. Provide units having series-wired design with replaceable surge-protection module.
  2. Provide units having audible alarm notification, LED diagnostic status indicator, and a Form C (SPDT) contact terminal block for remote notification of protection status.
- C. SPDs shall be Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the following:
  1. UL 1449, Type 1 or Type 2 SPD.
  2. UL 1283 for EMI and RFI filtering.
- D. Performance Criteria:
  1. MCOV: 150 V.
  2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase is 50 kA, minimum.
    - a. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
  3. Maximum Operating Current: 20 A.
  4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits.
    - a. Line to Neutral: 700 V, maximum.
    - b. Line to Ground: 700 V, maximum.

- c. Neutral to Ground: 1200 V, maximum.
  - d. Provide units that automatically self-restore without operator action
5. SCCR: AIC rating of circuit-breaker feeding circuit, minimum.

## 2.12 SURGE PROTECTION DEVICE (Communications Circuit)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide DITEK Surge Protection; Model DTK-2MHTPWB for telephone circuit, DTK-MRJPOES for Ethernet circuit, and/or DTK-VSPN for external wireless antenna signal or comparable product(s) by one of the following:
  - 1. Advanced Protection Technologies Inc. (APT)
  - 2. Liebert; a brand of Vertiv
- B. Provide SPDs on metal-conductor communication wiring and circuits extending outdoors, including telephone lines, Ethernet circuits, or wireless communication antenna cabling. Provide units having series-wired design.
- C. SPDs shall be Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the following:
  - 1. UL 497A, for telephone communications circuit SPD.
  - 2. UL 497B, for Ethernet data and wireless communication SPD.
- D. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating is 10 kA, minimum.

## 2.13 SURGE PROTECTION DEVICE (Data and Signaling Circuits)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide DITEK Surge Protection; Model DTK-2MHLP or comparable product by one of the following:
  - 1. Advanced Protection Technologies Inc. (APT).
  - 2. Liebert; a brand of Vertiv.
- B. Provide SPDs on metal-conductor data and signal wiring and circuits extending outdoors, including Signaling Line Circuit (SLC), Post Indicator Valve (PIV) supervision circuit, and Notification Appliance Circuit (NAC).
  - 1. SPDs shall utilize Series-wired design with replaceable surge-protection module.
  - 2. SPDs shall utilize Multistage, hybrid design that uses minimum two different types of surge-protection technology.
- C. SPDs shall be Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 497B, for data communications and fire-alarm circuits.
- D. Performance Criteria:
  - 1. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating is 20 kA, minimum.
  - 2. Maximum Operating Current: 5 A, for NAC/PIV surge protectors; 1 A for SLC surge protectors.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify products and systems receiving devices are ready for installation.

### 3.2 INSTALLATION

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Install conductors for fire alarm detection and signal circuit conductors in conduit.
- C. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
  - 1. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
  - 2. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.
- D. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
- E. Water-Flow and Valve Supervisory Switches: Connect to each sprinkler valve and Flow center assembly. Provide for quantity and locations shown on Fire Suppression shop drawings regardless of how many are shown on fire alarm system plans. Coordinate with fire suppression installer prior to bid.
- F. Connect conduit and wire to sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels, duct smoke detectors, elevator controllers and all other systems requiring fire alarm monitoring or interface.
- G. Automatic Detector Installation: Conform to NFPA 72.
- H. Install engraved plastic nameplates in accordance with Section 26 05 53.
- I. Ground and bond fire alarm equipment and circuits in accordance with Section 26 05 26.
- J. SPD Installation shall be as follows:

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Minimum Lead Length for Series-Wired SPDs: 3 ft. (915 mm).
3. Provide continuous ground wire from SPD to ground bar with bolted lug connections. Spliced ground conductors are unacceptable.
  - a. Do not connect ground wires from multiple SPD in series, daisy chain arrangement.
  - b. Do not connect ground wires from multiple SPDs in daisy chain arrangement. Connect each SPD ground to common grounding bus bar.
4. Install SPD in separate enclosure, outside equipment panel of system being protected.

### 3.3 FIELD QUALITY CONTROL

- A. Provide fire alarm documentation box adjacent to fire alarm panel per NFPA 72-7.7.2. Provide all record documents as well as all documentation defined in submittal section and NFPA 72-7.2.
- B. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- C. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
  1. Factory trained and certified personnel.
  2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level III certified personnel.
  3. International Municipal Signal Association (IMSA) fire alarm certified.
  4. Personnel licensed or certified by state or local authority.
  5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- D. Test entire fire alarm system in accordance with NFPA 72 and local fire department requirements.
- E. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
- F. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- G. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

- H. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
- I. Final Test, Certificate of Completion, and Certificate of Occupancy:
  - 1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

### 3.4 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

### 3.5 DEMONSTRATION AND TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
  - 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 hours' training.
  - 2. Schedule training with the Owner at least seven days in advance.

END OF SECTION 28 31 00

## SECTION 31 10 00 - SITE CLEARING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. This Section includes the following:
  - 1. Protecting existing trees and vegetation that are to remain;
  - 2. Clearing and grubbing; and,
  - 3. Topsoil stripping.

#### 1.02 REFERENCED SECTIONS

- 1. Section 01 32 23 – Survey and Layout Data
- 2. Section 01 57 13 – Temporary Erosion and Sediment Control
- 3. Section 31 20 00 – Earth Moving

#### 1.03 MATERIALS OWNERSHIP

- A. Except for materials indicated to be stockpiled or to remain on Owner's property, cleared materials shall become the Contractor's property and shall be removed from the site.

#### 1.04 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Existing utilities are shown on the Existing Conditions. The General Contractor is responsible for verifying utility locations. Careful attention should be given to the utilities marked to pothole by hand to locate.
- D. Contractor shall verify existing grades prior to performing work under this section. If existing grades are at variance with the drawings, notify the Owner and receive instructions prior to proceeding. No additional compensation will be considered resulting from grade variances once site clearing has commenced.
- E. All benchmarks and monuments shall be protected during construction. If disturbed or destroyed, they shall be replaced in original position by a licensed surveyor at the Contractor's expense.
- F. Protect areas outside limits of disturbance from encroachment by construction personnel or equipment, regardless of property Ownership. Access shall be by specific, written permission or easement only.

### PART 2 - PRODUCTS

- A. Contractor shall provide and use all necessary equipment and materials to perform work.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. Provide erosion control measures in accordance with Section 01 57 13, Temporary Erosion and Sediment Control, prior to any construction activity.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated. All trees and vegetation to remain shall be barricaded and protected during the construction process per Article 3.02 of this section.



- C. Limit of clearing is to be staked in accordance with Section 01 32 23, Survey and Layout Data, and verified by Owner prior to removal of any trees.
- D. All trees and shrubs not designated to remain within the area to be graded, whether shown or not on the drawings, shall be cut and the removal of stumps shall comply with Article 3.03 of this section. Burning on site is not permitted.

### 3.02 TREE PROTECTION

- A. Protect trees per the Clemson University Campus Tree Protection Policy
- B. If trees are intended to be protected are damaged, fines against the contractor can be levied as outlined in the Clemson University Campus Tree Protection Policy.
- C. Tree existing site improvements to remain, from damage during construction. Restore damaged improvements to their original condition, as acceptable to the Owner.
- D. Erect and maintain a temporary fence around tree protection line (1.5x drip line) of individual trees or around perimeter tree protection line of groups of trees to remain. Remove fence when construction is complete.
- E. Do not excavate within tree protection zone of trees, unless otherwise indicated.
- F. Where excavation for new construction is required within tree protection zone of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
- G. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Owner.
- H. Prior to installing any tree protection and beginning construction, contractor shall meet with Clemson Project Manager and Clemson Arborist to discuss tree protection installation.

### 3.03 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation within the limit of disturbance to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots, unless otherwise specified. In areas outside the building limits where the depth of fill exceeds 8 feet in height, unless otherwise directed by the Owner, sound trees shall be cut at a height of not more than 6 inches above natural ground.
- 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 and compact each layer to a density equal to adjacent original ground as in accordance with Section 31 20 00, Earth Moving.

### 3.04 TOPSOIL STRIPPING

- A. Strip topsoil to full depth encountered in areas indicated to be graded in a manner to prevent intermingling with underlying subsoil or waste materials.
- B. Stockpile sufficient topsoil material to facilitate seeding and landscaping. Stockpile away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water.
- C. Protect soil stockpiles as per Section 01 57 13, Temporary Erosion and Sediment Control.

### 3.05 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable or excess topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 10 00

## SECTION 31 20 00 – EARTH MOVING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Cutting, proof-rolling, filling and grading to required lines, dimensions, contours and elevations for proposed improvements as shown and implied on the drawings and required by these specifications prior to the fine grading discussed in the Playing Field Earthwork Specifications (Section 02300).
- B. Scarifying, compaction, moisture content conditioning and control, and removal of unsuitable material to ensure proper preparation of areas for the proposed improvements.
- C. Contractor to provide as-built topographic survey. Reference Survey and Layout specification section for information on necessary as-built to be provided by the Contractor.

#### 1.02 REFERENCED SECTIONS

- A. Section 01 32 23 - Survey and Layout Data

#### 1.03 RELATED DOCUMENTS

- A. Contract documents.

#### 1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) - latest edition
  - 1. D 422 Method for Particle Size Analysis of Soils
  - 2. D 698 Test for Moisture - Density Relations of Soils - Standard Proctor Method
  - 3. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
  - 4. D 2216 Laboratory Determination of Moisture content of Soil
  - 5. D 2487 Classification of Soils for Engineering Purposes
  - 6. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 7. D 3017 Test for Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 8. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
  - 9. D 4429 Standard Test Method for CBR (California Bearing Ratio) of Soils in Place
- B. American Association of State Highway and Transportation Officials (AASHTO) - latest edition
  - 1. T 88 Particle Size Analysis of Soils

#### 1.05 QUALITY ASSURANCE

- A. A geotechnical engineer, selected and paid by the Owner, can be retained by the Owner at their discretion to perform construction inspection on site based on density testing, visual observation, and judgement. This inspection will not relieve the Contractor from his responsibility to complete the work in accordance with the drawings and specifications.
- B. All costs related to re-inspection, due to failures, shall be paid for by the Contractor at no additional expense to Owner. The Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide full access to site for inspection activities.

#### 1.06 SUBMITTALS

- A. Within 10 days after award of the contract, the Contractor shall submit to the Owner, with his bid package, a schedule detailing the sequence, and time of completion of all phases of work under this section.

- B. At least 2 weeks in advance of imported fill use, the Contractor shall submit the following laboratory test data to the Engineer of Record for each type of imported soil/gravel material to be used as compacted fill.
  - 1. Moisture and Density Relationship: ASTM D1557 or D698;
  - 2. Mechanical Analysis: AASHTO T-88; and,
  - 3. Plasticity Index: ASTM D 4318.
- C. Together with the above test data, the Contractor shall submit a 5 pound sample of each type of off-site fill material in an air tight container for the approval of the Owner and Owner's Representative.
- D. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Owner and the Owner's Representative.
- E. When applicable, a blasting plan/pre blast reports shall be submitted 2 weeks prior to blasting commencement for review and approval by the Owner.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. On-site fill
  - 1. On-site materials for use as fill shall consist of excavated soil from other portions of the site;
  - 2. The Contractor shall use the on-site soil judiciously to facilitate the construction schedule including the use of the most readily compactable soil for fill in playing field areas and as fill within 2 feet of pavement subgrade;
  - 3. Topsoil shall not be utilized as engineered fill;
  - 4. Excavated material containing rock, stone or masonry debris smaller than 2 feet in its largest dimension, may be mixed with suitable material and utilized inside the playing field limits up to 6 feet below proposed subgrade; up to 3 feet below proposed subgrade outside the playing field limits;
  - 5. Excavated material containing rock, stone or masonry debris smaller than 6 inches in its largest dimension may be mixed with suitable material and utilized inside the playing field limits up to 3 feet below proposed subgrade; up to 18 inches below proposed subgrade outside the playing field limits;
  - 6. No material greater than 2 inches in its largest dimension may be utilized inside the playing field limits within 3 feet of proposed subgrade; within 18 inches of proposed subgrade for all other areas;

7. No material greater than 2 inches in its largest dimension may be utilized as backfill for storm drainage or utility trenches.
8. Prior to placement, on-site material to be used as fill shall not contain:
  - a. Debris other than crushed concrete and brick meeting the above requirements.
  - b. Timber or railroad ties.
  - c. Other deleterious materials such as steel rails, rebar, trash, etc.
  - d. Hazardous material - Unsuitable and deleterious materials and debris shall be disposed of off-site in accordance with all applicable regulations.
9. Fill shall be clean, well graded granular soil which is non-expansive and non-collapsible and shall have less than 20% by weight passing the #200 sieve. The portion passing the #200 shall be non-plastic. Fill with less-fines (less than #200) may be required on project specific bases. Likewise, fill with more than 20% fines may be acceptable on a project specific basis.

B. Off-site imported fill

1. If necessary, off-site fill shall be obtained and provided by the Contractor;
2. Fill shall be clean, well graded granular soil which is non-expansive and non-collapsible and shall have less than 20% by weight passing the #200 sieve. The portion passing the #200 shall be non-plastic. Fill with less fines (less than #200) may be required on project specific basis
3. Likewise, fill with more than 20% fines may be acceptable on a project specific basis;
4. Imported fill shall be free of all hazardous substances. Certification of compliance and, if requested, test results substantiating compliance shall be furnished to the Owner and Owner's Representative by the Contractor not less than one week prior to its intended use;
5. The Owner reserves the right to test off-site fill material for conformance with these specifications; and,
6. The Contractor shall be responsible for all permits and regulatory requirements associated with offsite borrow sources.

C. Rock is defined as follows:

1. General Excavation - Any material that cannot be excavated with a single-toothed ripper drawn by a crawler tractor having a minimum draw bar pull rated at not less than 71,000 lbs. (Caterpillar D9N or equivalent), and occupying an original volume of at least 2 cubic yards or more; and,
2. Trench Excavation - Any material that cannot be excavated with a backhoe having a break out force rated at not less than 44,000 lbs. (Caterpillar 235D or equivalent), and occupying an original volume of at least 2 cubic yards.
3. Mechanical Excavation - Any material that must be excavated by a minimum 10,000 lb. mechanical hammer and occupying an original volume of at least 2 cubic yards.

- D. Any bituminous concrete on the site shall be milled & removed prior to placing any fill and shall be reused only onsite immediately below the pavement stone base course.

2.02 EQUIPMENT

- A. Compactor for mass earthwork shall be minimum 5 ton static drum weight vibratory roller or 5 ton static drum weight sheeps footed compactor as appropriate for the type of soil material at the site or other compactor approved by the geotechnical engineer/ Owner's Representative.
- B. Compactor for trenches and where access or maneuverability is limited use, a double drum walk behind roller or vibratory plate compactor or "jumping jack" tampers.

PART 3 - EXECUTION

3.01 GENERAL

EARTH MOVING

- A. Prior to bidding of all work within this section, the Contractor shall become thoroughly familiar with the site, site conditions, and all portions of the work falling within this section.
- B. The Contractor shall refer to the erosion control drawings for staging of earthwork operations and for erosion control measures to be implemented prior to commencement of earthwork.
- C. Locate and identify existing utilities that are to remain and protect them from damage.
- D. Notify utility companies to allow removal and/or relocation of any utilities that are in conflict with the proposed improvements.
- E. Protect fences, structures, sidewalks, paving, curbs, etc to remain from equipment and vehicular traffic.
- F. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed/relocated it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same at no additional cost to the Owner.
- G. Remove from the site, material encountered in grading operations that, in opinion of Owner or geotechnical engineer/ Owner's Representative, is unsuitable or undesirable for backfilling in pavement or playing field areas as per Article 2.01.
- H. Identify required lines, levels, contours and datum to bring site grades to the proposed subgrade conditions inferred from the drawings.
- I. Do not perform any work associated with this section prior to completion of all required inspections, tests and approvals.
- J. When performing grading operations during periods of prolonged wet or dry weather, provide adequate measures for surface drainage and ground water control, and moisture control of soils (i.e., wetting or drying, scarify and discing) so as to place and compact the soil within the moisture content range a few percentage points of its optimum water content. Any disturbed areas should be proof-rolled at the end of each day.
- K. Sloping, shoring, bracing, and fencing shall be installed in accordance with Federal OSHA requirements as well as the requirements of all regulatory authorities having jurisdiction.
- L. Allow no debris to accumulate on-site. Haul debris away from the site and dispose of at no cost to the Owner.
- M. Dispose of excess earth material from the site.

### 3.02 COMPACTION OF SUBGRADE SURFACES

- A. All fill used for raising site grade or for replacement of material that is undercut should be uniformly compacted in thin lifts to at least 95% of the Standard Proctor Maximum Dry Density (ASTM D698). In addition, at least the upper 12" of subgrade fill beneath pavements and floor slabs should be compacted to 98% of the maximum dry density. It is recommended for the fill to be placed and compacted at a moisture content within three percent of the standard Proctor optimum moisture content.
- B. Additionally, the surfaces of floor slabs and pavement subgrades that have deteriorated due to freezing, erosion gullies, extreme drying, exposure for a long period of time shall be recompacted prior to construction of the floor slab or pavement.
- C. Any excavations through the subgrade soils should be properly backfilled in compacted lifts. Recompanction of subgrade surfaces and compaction of backfill should be checked with a sufficient number of density tests to determine if adequate compaction is being achieved.
- D. In areas to receive fill and at the final cut subgrade, proof-roll and compact the exposed ground surface following clearing and grubbing and any required excavation with a minimum of 4 passes of an approved compactor and as indicated below.

TABLE 3.02

Location or Area	Standard Proctor Density ASTM D698	Testing Frequency 1 per lift per
Structures and Walkways	98%	20,000 sf
Retaining Walls	98%	1,000 sf
Trenches	95%	150 lf
Lawn or Unimproved Areas	95%	20,000 sf
Building and Pavement Sub- grades (Top 18 inches)	98%	10,000 sf
Building and Pavement Sub- grades (Below Top 18 inches)	98%	15,000 sf

\*or as specified in the geotechnical report if greater than values noted in table above

- E. In addition to the above referenced table, proof-rolling shall be completed in accordance with Section 3.06, “Proof-rolling”.
- F. Any soft areas exhibiting excessive weaving or unsatisfactory material identified during excavation, fill placement, compaction and proof testing shall be removed, replaced with suitable fill, and compacted as specified in Table 3.02 above.
- G. Prior to preparing the subgrade in low lying areas, perform the following procedures:
  - 1. Drain standing water by gravity or with a pump. Water should not be discharged directly to a storm drain system;
  - 2. After drainage of low area is complete, remove mulch, mud, debris, and other unsuitable material using equipment and methods that will minimize disturbance to the underlying soils;
  - 3. Thoroughly compact subgrade as specified in Article 3.02.A and Article 3.05 or 3.06 of this Section; and,
  - 4. If proposed for fill, all muck, mud and other materials removed from above low areas shall be dried on-site by spreading in thin layers for observation by Owner or Owners representative. If, after observation by Owner or Owners representative, material is found to be unsuitable, it shall be removed from the site.

### 3.03 UNDERCUT EXCAVATION

- A. When approved by Owner and recommended by the Engineer of Record / Owner’s Representative, the Contractor may be required to remove natural soil materials in areas where fills are to be placed when determined to be undesirable in their location or condition. The Contractor shall be required to remove the undesirable material and backfill with approved material properly compacted.
- B. At locations where unstable soil is shown on the drawings, the removal and replacement of such soil shall be as directed on the drawings or as directed by the Engineer of Record / Owner’s Representative and the Owner.
- C. At locations where soil is wet of optimum moisture, the Contractor shall provide a “good faith” effort in drying and discing these areas prior to completing undercut excavation as approved by the Engineer of Record / Owner’s Representative and Owner.

- D. Where undercutting is required adjacent or beneath the location of the proposed drainage structure, undercut and backfill shall be done over a sufficient distance adjacent to the installation to prevent future operations from disturbing the completed drainage structure.
- E. All material removed in the work of undercut excavation will be classified by the geotechnical engineer/ Owner's Representative and Owner as either suitable for other use without excessive manipulation and utilized by the Contractor elsewhere in the work, or unsuitable for future use and disposed of by the Contractor as directed by the geotechnical engineer/ Owner's Representative.
- F. The Contractor shall conduct undercut operations in such a way that the necessary measurements can be taken before any backfill is placed.
- G. Backfill in undercut areas shall be placed as a continuous operation along with the undercutting operation. No backfill material shall be placed in water unless otherwise permitted by the geotechnical engineer/ Owner's Representative.

### 3.04 ROCK EXCAVATION

- A. General Rock Excavation & Blasting – The encountering and removal of rock as defined herein this section will be paid as part of the project excavation unless stated elsewhere in the contract documents.
  - 1. Rock Required Removal Lines:
    - a. Two feet outside of concrete work for which forms are required, except footings;
    - b. One foot outside perimeter of footings where forms are required. Additional depth may be required due to local codes;
    - c. Neat outside dimensions of concrete work where no forms are required; and,
    - d. Under slabs on grade, 6 inches below subgrade.
- B. Blasting Requirements: No blasting is allowed.

### 3.05 EXCAVATION, FILL, AND SUBGRADE PREPARATION

- A. GENERAL
- B. EXCAVATION
  - 1. Where existing grades are above proposed subgrade elevation, excavate materials to line and grade as shown in the drawings being careful not to over excavate beyond the elevations needed for sub-grades;
  - 2. Excavate organic soils from within the building. Excavated on-site organic soils, which are unsuitable for playing field fill may be used in landscaped areas. Otherwise this material shall be disposed of off-site;
  - 3. Excavated on-site soils, which meet the requirements of the geotechnical engineering study may be used as building aea; and,
  - 4. Unsuitable material, such as wood and any other deleterious materials determined to be unsuitable by the geotechnical engineer/ Owner's Representative for use as on-site fill, shall be disposed of off site.
- C. SUBGRADE PREPARATION FOR FILL
  - 1. Existing grades below building shall be leveled prior to fill placement. The Contractor shall remove existing lawn and top soil in these areas prior to placement of any fill; and,
  - 2. All existing grades below building shall be proof-rolled and compacted per Article 3.02.
- D. FILL PLACEMENT
  - 1. No fill material shall be placed in areas of standing water, in areas of frozen or thawing ground, or in areas that have not been approved by the geotechnical engineer/ Owner's Representative;
  - 2. No fill materials shall be placed during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until all saturated surficial soils are returned to a satisfactory moisture content as determined by the geotechnical engineer/ Owner's Representative;

3. Fill lift surfaces shall be made smooth and free from ruts or indentations at the end of any work day when precipitation is forecast to prevent saturation of surficial fill material. Fill surfaces shall be graded to drain and sealed with a smooth drum roller at the completion of each work day;
4. The fill shall be placed in uniform loose lifts not exceeding 12 inches and compacted in systemic method to achieve at least 6 passes of the compactor. Larger lift thickness, but no greater than 2 feet shall be permitted if broken rock is utilized and placed at least 6 feet below of finished grade;
5. Shot rock may be utilized as engineered fill as approved by the geotechnical engineer/ Owner's Representative;
6. Each lift shall be compacted to the minimum densities listed in Table 3.02 as appropriate for the project;
7. The Contractor shall adjust the water content by aeration or adding water to achieve the required density. Assist drying by disc, harrow, or pulverizing until moisture content is reduced to achieve proper compaction and facilitate the construction schedule;
8. Wet, saturated material shall be air dried as necessary to achieve the field densities specified in this Section. Removal and replacement shall not occur without prior approval or Owner. Removal and replacement shall be used if necessary to facilitate the construction schedule;
9. Remove areas of finished subgrade found to have insufficient compaction density of depth necessary and replace with suitable compacted fill as approved by the Owner or Owners representative. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section; and,
10. Fill placed on slopes greater than 1 vertical to 3 horizontal shall have each lift benched onto the slope at least 3 feet.

### 3.06 PROOFROLLING

- A. The work covered by this subsection consists of furnishing and operating, proof-rolling equipment at the direction of the Owner's representative and/or geotechnical engineer.
- B. Proof-rolling shall be under the observation of the Owner's representative and/or the geotechnical engineer as described herein and under the following schedule:
  1. Immediately following the completion of excavation to proposed sub-grades in cut areas, proof-rolling shall be performed as specified; and,
  2. Immediately **prior to and following** stone base course placement, in pavement and playing field areas for final floor slab preparation, all subgrade and stone base areas shall be proof-rolled. Any areas which deflect, rut or pump under the loaded dump truck shall be undercut and replaced with compacted fill material or stone base course as directed by the geotechnical engineer/ Owner's Representative and approved by the Owner, at no additional cost to the Owner.
- C. Proof-rolling shall be done with 1 pass of a fully loaded tandem dump truck equal to or exceeding 50,000 lbs or other construction equipment if approved by the geotechnical engineer/ Owner's Representative.

END OF SECTION 31 20 00



## SECTION 31 23 17 - TRENCHING AND EXCAVATION

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Work under this section shall include, but not be limited to excavating trenches for the installation of storm drains and utilities, backfilling trench with bedding material as specified and finish filling trenches with suitable material to proposed subgrade, compacting subgrade, bedding, and backfill materials, and compliance with all environmental and health and safety regulations.
- B. This work shall include all labor and materials and equipment necessary to meet all applicable requirements as specified in the contract documents.

#### 1.02 REFERENCED SECTIONS

- A. Section 31 20 00 - Earthmoving
- B. Section 33 40 00 - Storm Drainage

#### 1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) Latest Edition
  - 1. D 422 Method for Particle Size Analysis
  - 2. D 698 Test of Moisture Density Relations of Soils - Standard Proctor Method
  - 3. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb. (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
  - 4. D 2216 Laboratory Determination of Moisture Content of Soil
  - 5. D 2487 Classification of Soils for Engineering Purposes
  - 6. D 2922 Tests for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 7. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 8. D 4318 Test for Plastic Limit, Liquid Limit, & Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
  - 1. T 88 Mechanical Analysis of Soils
  - 2. M 43 Standard Sizes of Coarse Aggregate for Highway
- C. National Electric Code
  - 1. NEC 300-5
  - 2. NEC 710-36

#### 1.04 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of all subsurface utilities, structures and obstructions encountered.
- B. Accurately record any as-built variation from the construction drawings and specifications. The Contractor shall provide as-built drawings within 14 days of project completion.

#### 1.05 QUALITY ASSURANCE

- A. A geotechnical engineer, selected and paid by the Owner, may be retained to perform construction inspection and testing on backfilling operations as stated herein. This inspection will not relieve the Contractor from his responsibility to complete the work in accordance with the drawings and specifications.

#### 1.06 PROJECT CONDITIONS

- A. Removal/Relocation of Existing Utilities: The contractor shall be responsible for removal and/or relocation of existing utilities, whether shown or not shown on the drawings, at locations where conflicts occur with proposed utility improvements at no additional cost to the owner.

#### 1.07 SUBMITTALS

- A. The Contractor shall contact all utility companies and identify any requirements. Contractor shall provide written confirmation of the status of all utility construction to the Owner at the time of the preconstruction conference or no later than 30 days following the project possession date.
- B. Submit a sample of each type of offsite fill and/or bedding material that is to be used in backfilling in accordance with Section 31 20 00 – Earth moving.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Backfill material shall be as specified and approved by the Owner and/or the geotechnical engineer.
- B. Bedding Material: Bedding material shall only be utilized when specified on the drawings. Bedding material shall conform to local code or AASHTO M43 No. 57 course aggregate free from debris, clay lumps, organic, or other deleterious material.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. Set all lines, elevations, and grades for utility and drainage system work and maintain for the duration of work. Provide careful maintenance of benchmarks, property corners, monuments, or other reference points.
- B. Protect and maintain in operating condition, existing utilities encountered during utility installation. Repair any damage to surface or subsurface improvements shown on Drawings.
- C. Verify location, size, elevation, and other pertinent data required to make connections between existing utilities, drainage systems, and proposed construction indicated on Drawings. Coordinate all building utility connection locations and elevations with architectural drawings. Contractor shall comply with all local codes and regulations.
- D. Install dewatering systems that will be required to construct the proposed utilities to the design elevations. Water pumped out of excavations shall be disposed of on-site, and will not be discharged directly to the municipal storm drainage system, unless otherwise approved.
- E. Where the foundation material is found to be of poor supporting value or of rock, the Owner's engineer may make minor adjustments in the location of the pipe to provide a more suitable foundation. Where this is not practical, the foundation shall be conditioned by removing the existing foundation material by undercutting to the depth as directed by the geotechnical engineer and backfilling with either a suitable local material secured from unclassified excavation or borrow excavation at the nearest accessible location along the project, or foundation conditioning material consisting of crushed stone or gravel or a combination of sand and crushed stone or gravel approved by geotechnical engineer as being suitable for the purpose intended. The selection of the type of backfill material to be used for foundation conditioning will be made by the project manager.

#### 3.02 TRENCH EXCAVATION

- A. Contact regulatory authorities having jurisdiction and utility companies before excavation begins. Dig trenches at proper width and depth for laying pipe, conduit, or cable and in accordance with utility company requirements. Cut trench banks for safety and remove stones as necessary to avoid point-bearing.

- B. All trench excavation side walls shall be sloped, shored, sheeted, braced or otherwise supported by means of sufficient strength to protect the workmen within them in accordance with the applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by regulatory authorities having jurisdiction, codes and ordinances.
- C. Trench width requirements below the top of the pipe shall not be less than 12 inches nor more than 18 inches wider than outside surface of any pipe or conduit that is to be installed. All other trench width requirements for pipe, conduit, or cable shall be the minimum practical width that will allow for proper compaction of trench backfill and satisfy safety and utility company regulations.
- D. Provide uniform bearing and support for each section of pipe at every point along the entire length, except where necessary to excavate for bell holes, pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make the joint connection properly.
- E. During excavation, stockpile excavated material suitable for backfilling in an orderly manner far enough from the trench to avoid overloading and slides.
- F. Remove excavated materials from the site which are not suitable for backfill.
- G. Any abandoned structures utilities or debris discovered during excavation shall be removed and disposed of, or capped.
- H. Utility alignments have been designed to avoid expected obstructions wherever possible. If unanticipated significant obstructions are encountered during utility installation work immediately notify the Owner.
- I. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as necessary. Remove accumulated water in trenches or other excavations by pumping or other acceptable methods. Water shall not be directly pumped to the city sewer system.
- J. Utility installation shall meet the following minimum pipe installation depths, or applicable codes and ordinances, measured from finished grade.
  - 1. Water Mains: 42 inches to top of pipe barrel or 12 inches below the frost line (established by the regulatory authorities having jurisdiction ), whichever is deeper, or as specified on the plans;
  - 2. Sanitary Sewer: Elevations, and grades as indicated on drawings (36 inches minimum);
  - 3. Storm Sewer: Elevations, and grades as shown on drawings (24 inches minimum);
  - 4. Electrical Conduits: 24 inches to top of secondary service conduits, 36 inches minimum to the top of primary service conduits, or as required by NEC 300-5, NEC 710-36 codes, or the regulatory authorities having jurisdiction, and utility company requirements, whichever is deeper;
  - 5. Telephone Conduits: 24 inches to top of conduit, or as required by the regulatory authorities having jurisdiction and utility company, whichever is deeper; and,

### 3.03 TRENCH ROCK EXCAVATION

- A. Trench Rock Excavation and Blasting – The encountering and removal of rock as defined herein this section will be paid as part of the corresponding utility items unless stated elsewhere in the contract documents.
  - 1. Rock Required Removal Lines: In utility trenches, 12 inches below invert elevation of pipe and a minimum of 12 inches wider than the outside surface of any pipe or conduit that is to be installed.
- B. Blasting Requirements: NO BLASTING IS ALLOWED.

### 3.04 LATERALS

- A. All utilities intended to connect to services within any building will be extended to within 5 feet of the building limits in the direction and at elevations to connect at those geometrical locations indicated or inferred on the drawings. All utility ends will be plugged and marked by a 2 inch x 4 inch piece of wood extending from the utility invert to 4 feet above final grade.

3.05 PIPE BEDDING (When Specified)

- A. Accurately cut trenches for pipe or conduit to designated line and grade 6 inches below the bottom of the pipe, to width as specified previously. Compact trench bottoms a minimum of 92% of the maximum dry density as determined by ASTM D1557, Modified Proctor Test.
- B. Over excavate wet or unstable soil, if encountered, from trench bottom as necessary to provide a suitable base for continuous and uniform bedding.
- C. Place bedding material and compact in 6 inch loose lifts to obtain at least 92% of the maximum dry density per ASTM D1557. Accurately shape bedding material to conform to lower portion of pipe barrel. After pipe installation, place and compact bedding material as specified above in maximum 6 inch loose layers to the springline of the pipe.

3.06 BACKFILLING

- A. The fill around the pipe shall be placed in accordance with the details shown on the drawings, and shall be placed in layers not to exceed 8 inches loose unless otherwise approved by the engineer and compacted to at least 95% of the maximum dry density as determined in accordance with ASTM D698, Standard Proctor, or 92% of the maximum dry density as determined in accordance with ASTM D1557, Modified Proctor. The geotechnical engineer shall approve all backfill material. Select material shall be used when called for on the drawings or when required by the geotechnical engineer.
- B. Care shall be taken during backfill and compaction operations to maintain alignment and prevent damage to the joints. The backfill shall be kept free from stones, frozen lumps, chunks of highly plastic clay, or other objectionable material.
- C. All pipe backfill areas shall be graded and maintained in such a condition that erosion or saturation will not damage the pipe bed or backfill.
- D. Heavy equipment shall not be operated over any pipe until it has been properly backfilled with a minimum 2 feet of cover. Where any part of the required cover is above the proposed finish grade, the Contractor shall place, maintain, and finally remove such material at no cost to the Owner. Pipe which becomes misaligned, shows excessive settlement, or has been otherwise damaged by the Contractor's operations shall be removed and replaced by the Contractor at no cost to the Owner.
- E. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces. Should these conditions exist, the areas should be removed, replaced and recompact as per Section 31 20 00, Earth Moving.

END OF SECTION 31 23 17

## SECTION 31 31 16 - TERMITE CONTROL

### 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:
  - 1. Soil treatment with termiticide under and around perimeter of BUILDING ADDITIONS ONLY.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Service Life of Soil Treatment: Soil treatment by use of a termiticide that is effective for not less than five years against infestation of subterranean termites.
- B. SUBMITTALS
- C. Product Data: For termiticide.
  - 1. Include the EPA-Registered Label for termiticide products.
- D. Product Certificates: For termite control products, signed by product manufacturer.
- E. Qualification Data: For Installer of termite control products.
- F. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following:
  - 1. Date and time of application.
  - 2. Moisture content of soil before application.
  - 3. Brand name and manufacturer of termiticide.
  - 4. Quantity of undiluted termiticide used.
  - 5. Dilutions, methods, volumes, and rates of application used.
  - 6. Areas of application.
  - 7. Water source for application.
- G. Warranty: Special warranty specified in this Section.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.
- B. Regulatory Requirements: Formulate and apply termiticides according to the EPA-Registered Label.
- C. Source Limitations: Obtain termite control products through one source.

#### 1.5 PROJECT CONDITIONS

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

#### 1.6 COORDINATION

- A. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
  - 1. Warranty Period: Five years from date of Substantial Completion written in the form of an insurance policy in the amount of \$100,000.00 for damages to the building and contents. Rating of insurance company shall be A-, IV (4).
  - 2. Shall be secured with a bond by a State-licensed Surety
  - 3. If evidence of termites occur within warranty period, areas shall be retreated at no cost to the owner.
  - 4. Include optional renewal policy on annual basis after fifth year; fee shall be equitable and agreed upon by applicator and Owner.
  - 5. Inspect and report annually to the Owner in writing.

## PART 2 - PRODUCTS

### 2.1 SOIL TREATMENT

- A. Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.
  - 1. Shall be acceptable to the US Dept. of Agriculture for use in controlling termites without being injurious to plant life.
  - 2. Only manufacturer pre-mixes permitted. No job-mixing of chemicals.
  - 3. Diluent as recommended by toxicant manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil, interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control.
  - 1. Proceed with application only after unsatisfactory conditions have been corrected.
  - 2. Notify Architect at least 48 hours prior to application.
  - 3. Post signs in areas of applications, warning that poison has been applied; leave signs in place for minimum 2 weeks following application.

### 3.2 PREPARATION

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
  - 1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

### 3.3 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

### 3.4 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
  - 1. Slabs-on-Grade: Under ground-supported slab construction, including footings (both sides), building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed. Apply toxicant 12 hours prior to installation of vapor barrier.
  - 2. Foundations: Adjacent soil including soil along the entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating the slab, and around interior column footers, piers, and chimney bases; also along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
  - 3. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
  - 4. Soil within 10 feet of building ADDITION perimeter.
- B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
- D. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 31 31 16



## SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

### 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. Cold-applied joint sealants.
  - 2. Cold-applied, fuel-resistant joint sealants.
  - 3. Joint-sealant backer materials.
  - 4. Primers.
- B. Related Requirements:
  - 1. Section 07 92 01 "Site Joint Sealants" for sealing nontraffic and non-pavement joints.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors or each kind of joint sealant required.
- C. Paving-Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Product Certificates: For each type of joint sealant and accessory.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
- C. Mockup: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for execution.
  - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work.

## 1.6 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
  - 2. When joint substrates are wet.
  - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

### 2.2 COLD-APPLIED JOINT SEALANTS

- A. Single Component, Pourable, Urethane, Elastomeric Joint Sealant – PJS-#1: ASTM C 920, Type S, Grade P, Class 25, for Use NT.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Meadows, W.R., Inc.: “Pourthane SL” or a comparable product by one of the following:
    - a. BASF
    - b. Pecora Corporation.

2. Color: As selected by Architect from manufacturer's full range.
- B. Single Component, Pourable, Urethane, Elastomeric Joint Sealant – PJS-#2: ASTM C 920, Type S, Grade P, Class 25, for Use T.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Meadows, W.R., Inc.: "Pourthane SL" or a comparable product by one of the following:
    - a. BASF
    - b. Pecora Corporation.
  2. Color: As selected by Architect from manufacturer's full range.

## 2.3 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
- B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

## 2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  1. Do not leave gaps between ends of joint-sealant backings.
  2. Do not stretch, twist, puncture, or tear joint-sealant backings.
  3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
  1. Place joint sealants so they fully contact joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
  1. Remove excess joint sealant from surfaces adjacent to joints.
  2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

### 3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

### 3.5 PAVING-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving PJS-#1.
  - 1. Joint Location:
    - a. Joints between concrete and asphalt paving.
    - b. Joints between concrete curbs and asphalt paving.
    - c. Other joints as indicated.
  - 2. Joint-Sealant Color: As selected by Architect.
- B. Joint-Sealant Application: Fuel-resistant joints within concrete paving PJS-#2.
  - 1. Joint Location:
    - a. Expansion and isolation joints in concrete paving.
    - b. Other joints as indicated.
  - 2. Joint-Sealant Color: As selected by Architect.

END OF SECTION 32 13 73

## SECTION 32 14 00 - UNIT 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. Concrete unit pavers set in sand setting beds over CIP Concrete subbase.

- B. Related Requirements:

- 1. Section 03 30 01 "Site Cast-In-Place Concrete" for curbing and concrete base under unit pavers.
  - 2. 31 20 00 "Earth Moving" for aggregate base courses.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
- C. Samples for Verification: For full-size units of each type of unit paver indicated. Include the following:
  - 1. Concrete unit paver.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

- 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.

## 1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

- 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store aggregates and sand where grading and other required characteristics can be maintained and contamination avoided.
- C. Store liquids in tightly closed containers protected from freezing.

## 1.8 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

## 2.2 CONCRETE PAVERS

- A. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936/C 936M and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.

1. Subject to compliance with requirements, provide one of the following manufacturers products;
  - a) Hanover Architectural Products;
  - b) Product; Traditional Prest Paver
  - c) Thickness; 3 inches
  - d) Face Size and Shape; 12-inch by 12-inch
  - e) Pattern (Field); TBD
  - f) Finish: Tudor
  - g) Colors; up to three colors:
    - 1) Limestone Gray: TBD
    - 2) Charcoal: TBD
    - 3) Natural: TBD
    - 4) Band: Limestone Gray: 100 percent
  - a) Wausau Tile;
  - b) Product; EcoPremier Paver
  - c) Thickness; 3 inches
  - d) Face Size and Shape; 12-inch by 12-inch
  - e) Pattern (Field); TBD
  - f) Finish: Standard
  - g) Colors; up to three colors:
    - 1) HEP-10: TBD
    - 2) HEP-20: TBD
    - 3) HEP-50: TBD
    - 4) Band: HEP-10: 100 percent
  - a) Unilock;
  - b) Product; Smooth Premier Paver
  - c) Thickness; 2-3/4-inches
  - d) Face Size and Shape; 11-7/8-inch by 11-7/8-inch
  - e) Pattern (Field); TBD
  - f) Finish: Standard
  - g) Colors; up to three colors:
    - 5) Opal: TBD
    - 6) Opal Blend: TBD
    - 7) Granite: TBD
    - 8) Band: Opal: 100 percent

## 2.3 SETTING-BED MATERIALS

- A. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate.
- B. Polymeric Sand for Joints: Manufacturer's mixture of polymer binders and fine sand made for paving joint applications.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Alliance; “Gator Mass” or a comparable product by one of the following:



- a. Techniseal; "RG+Polymeric Sand."
  - b. SEK Surebond; "Polysweep Polymeric Sand."
  - c. Color: Slate gray.
- C. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
- 1. Survivability: Class 2, AASHTO M 288.
  - 2. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
  - 3. Permittivity: 0.02 per second, minimum; ASTM D 4491.
  - 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
- D. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
- 1. Survivability: Class 2, AASHTO M 288.
  - 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
  - 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
  - 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
- E. Portland Cement: ASTM C 150, Type I or II.

## 2.4 PAVING SEALER

- A. Paving Sealer:
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hanover Products, "Hanover Natural Sealer" or a comparable product by one of the following: ~~or a comparable product applied to installed pavers according to manufacturer's recommendation.~~
    - a) Dyco
    - b) Product; Paver Sealer
    - c) Mfg. SKU; DYC7200
  - a) RadonSeal
  - b) Product; Paver Sealer
  - c) Mfg. SKU; 160

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

### 3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
  - 1. Core drill pavers to fit around round objects.
- D. Joint Pattern: As indicated.
- E. Do not cut pavers to less than 1/4 of the unit length. Fill space with oversized paver cut to fit, or cut adjacent paver in the course to 3/4 its original length, and cut standard paver to fit remaining space.
- F. Pavers on Structure over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
- G. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- H. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install nails or stakes at intervals required to hold edge restraints in place during and after unit paver installation.

### 3.4 SETTING-BED APPLICATION

- A. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.
- B. Pavers Set on Concrete Base: Fill weep holes with coarse sand.
- C. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- D. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.
- E. Spread dry polymeric sand and fill joints immediately after vibrating pavers into leveling course. Comply with manufacturer's written instructions for filling joints, vibrating, and watering.
- F. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- G. Repeat joint-filling process 30 days later.

### 3.5 PAVER SEALANT

- A. Apply paver sealant product according to manufacturer's recommendation.

### 3.6 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 32 14 00

## SECTION 32 16 00 - CONCRETE CURBS, GUTTERS, SIDEWALKS AND DRIVEWAYS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. This Section includes all portland concrete pavement outside the building limits, including but not limited to:
  - 1. Driveways and roadways
  - 2. Parking lots
  - 3. Curbs and gutters
  - 4. Sidewalks
- B. For concrete located within the building limits: refer to Cast-In-Place Concrete

#### 1.02 REFERENCE STANDARDS

- A. American Society of Testing Materials (ASTM)
  - 1. A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
  - 2. A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
  - 3. A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  - 4. C33 - Standard Specification for Concrete Aggregates
  - 5. C94 - Standard Specification for Ready-Mixed Concrete
  - 6. C150 - Standard Specification for Portland Cement
  - 7. C171 - Standard Specification for Sheet Materials for Curing Concrete
  - 8. C260 - Standard Specification for Air-Entraining Admixtures for Concrete
  - 9. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
  - 10. C494/C494M - Standard Specification for Chemical Admixtures for Concrete
  - 11. C979 - Standard Specification for Pigments for Integrally Colored Concrete
  - 12. C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete
  - 13. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
  - 14. D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
  - 15. D3405 - Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements
  - 16. D5249 - Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
  - 17. D5893 - Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
- B. American Concrete Institute (ACI)
  - 1. 301R-99 – Specifications for Structural Concrete
  - 2. 304R – Placing and Handling Concrete, etc.
  - 3. 309R-96 – Guide for Consolidating of Concrete
  - 4. 330.1 – Standard Specifications for Plain Concrete Parking Lots
  - 5. 330R-92 – Guide for Design & Construction of Concrete Parking Lots
  - 6. 211.1R-91 – Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
- C. American Association of State Highway and Transportation Officials (AASHTO)

1. M182 – Standard Specifications for Burlap Cloth made from Jute for Kenaf
2. M153 – Standard Specifications for Preformed Sponge Rubber and Cork Expansion Joint Filler

1.03 SUBMITTALS

- A. Mix Design: For each concrete mix indicated (see attached form).
- B. Material certificates and test reports.
- C. The General Contractor and the Subcontractor shall execute the Conformance Submittal(s) at the end of this section.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

- A. The type of steel reinforcement shall be as shown on the drawings.
  1. Plain-Steel Welded Wire Fabric: ASTM A 185, 6inches x 6inches #10 mesh fabricated from steel wire into flat sheets;
  2. Reinforcement Bars: ASTM A 615/A 615M, Grade 40, deformed;
  3. Plain Steel Wire: ASTM A 82, as drawn; and,
  4. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening steel reinforcement. Manufacture bar supports according to CRSI's Manual of Standard Practice.

2.02 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I, II or III.
- B. Aggregate: ASTM C 33. Combined aggregate gradation for concrete pavement and other designated concrete shall be 8% - 18% for large top size aggregates (1½") or 8% - 22% for smaller top size aggregates (1" or ¾") retained on each sieve below the top size and above the No. 100 sieve. Concrete pavements shall have a maximum aggregate size of 1½".
- C. Water/Ready Mix Concrete: ASTM C 94.
- D. Admixtures: Certified by manufacturer to contain not more than 0.1 % water-soluble chloride ions by mass of cement and to be compatible with other admixtures, as follows:
  1. Air-Entraining Admixture: ASTM C 260;
  2. Water-Reducing Admixture: ASTM C 494, Type A;
  3. Water-Reducing and High-Range Admixture: ASTM C 494, Type F;
  4. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E; and,
  5. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- E. Fly Ash: The use of fly ash is prohibited.
- F. Calcium Chloride: The use of calcium chloride or admixtures containing more than 0.05% chloride ions is prohibited.
- G. Curing Materials:
  1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry;
  2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet;
  3. Water: Potable;
  4. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete;
  5. Clear Solvent-Borne Liquid-Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B;
  6. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B;

7. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

2.03 CONCRETE MIXES AND MIXING

- A. Concrete Mixes: Prepare design mixes, proportioned according to ACI 211.1R-91 and ACI 304, with the following properties:
  - 1. Compressive Strength (28 Days): 3,000 psi;
  - 2. Slump Limit: maximum of 5 inches at time of placement for pavement, 3 inch maximum for curb and sidewalk;
  - 3. Air Content: 5% to 8% for pavement, curb and sidewalk.
- B. Coloring Agent: When required, add coloring agent to mix according to manufacturer's written instructions.
  - 1. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork; and,
  - 2. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
- C. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 1116.
- D. Project-Site Mixing: On-site mixing must be approved by the Owner. Comply with requirements and measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

2.04 JOINTS, FILLERS, AND SEALANTS

- A. Joint-Sealant Backer Materials: ASTM D5249, Non-Staining, compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.
- B. Joint Sealant: Non-priming, pourable self-leveling silicone sealant for concrete and asphalt.
  - 1. Cold-Applied Joint Sealant ASTM D5893, self leveling silicone sealant. Crafcro Inc. "Roadwaver Silicone-SL"; Dow Corning "888, or 890-SL"; Sonneborn "Sonomeric 1 Sealant"; Tremco "Vulkem 45"; and,
  - 2. Hot-Applied Joint Sealant: ASTM D3405, Polymeric sealant. Crafcro Inc. "ROADSAVER 22"; W.R. Meadows, Inc. "SEALTIGHT HI-SPEC".
- C. Joint Fillers: Resilient pre-molded bituminous impregnated fiberboard units complying with ASTM D 1751, asphalt-saturated cellulosic fiber, ASSHTO M 153, Type I: or ASTM D 1752, cork or self-expanding cork.
- D. Exterior Concrete Sealant: Sonneborn "Kure-N-Seal 30" exterior acrylic sealer, or Euclid "Super Rez-Seal".

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Surface Preparation: Proof-roll prepared subbase, per Section 31 20 00 – Earth Moving and remove loose material from surface.
- B. Forms: Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations, per Section 01 32 23, Survey and Layout.
  - 1. Maintain sufficient quantity of forms to allow continuance of work so that forms remain in place a minimum of 24 hours after concrete placement;
  - 2. Forms shall be cleaned and casted with form release agent thoroughly after each use and before concrete is placed; and,
  - 3. Flexible or curved forms shall be used on curves. Forms shall be of full depth of the concrete and of a strength when staked, sufficient to resist the presence of the concrete and the loads resulting from the finish operations without springing, setting or losing their shape.

- C. Reinforcement: Accurately position and support reinforcement, and secure against displacement. Set wire ties with ends directly into concrete.
  - 1. Install welded wire fabric in lengths as long as practicable; lap at least one full mesh, and lace splices with wire; and,
  - 2. Support reinforcing steel on wire chairs to ensure that wire stays mid-depth of sidewalk section during concrete pour.
- D. Joints: Construct pre-molded expansion and contraction joints, tied construction joints, thickened edge expansion joints, isolation joints, and construction joints, straight with face perpendicular to concrete surface. Construct transverse joints perpendicular to centerline unless otherwise detailed.
  - 1. Expansion joints and Contraction joints: Pre-molded as indicated on the drawings;
    - a. Provide joint filler for the entire depth of the slab section and not less than 1 inch below finished surface so as to allow for joint sealer.
    - b. Provide thickened edge expansion joint as indicated on the drawings.
    - c. Provide 1/2 inch contraction joints for curb and gutter at 10 feet on center.
    - d. Provide 1/2 inch expansion joints for curb and gutter and sidewalk at 100 feet on center.
  - 2. Tied construction joints: As indicated on drawings;
  - 3. Control joints: Depth shall be equal to  $\frac{1}{4}$  of the concrete thickness or 1 inch, whichever is deeper. For sidewalks, control joint spacing shall be equal to the sidewalk width. For concrete pavement, control joint spacing shall be placed as shown on the drawings, no greater than 15 feet on center either way;
    - a. Form tooled joints in fresh concrete by grooving top portion with recommended tool and finishing edges with jointer.
    - b. Form sawed joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete within 24 hours of the concrete placement and as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.
  - 4. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for period of more than  $\frac{1}{2}$  hour, except where such placements terminate at expansion joints. Construct joints using standard metal keyway-section forms or as shown on the drawings;
  - 5. Isolation Joints: Locate isolation joints as indicated on the drawings. Provide premolded joint filler for catch basins, manholes, inlets, structures, walks, light pole bases and other fixed objects;
  - 6. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than  $\frac{1}{2}$  inch or more than 1 inch below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together; and,
  - 7. Joint Sealants: All joints shall be sealed with approved exterior pavement joint sealants and shall be installed per manufacturer's recommendations.
- E. Concrete Placement: Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete. Place concrete in a continuous operation within planned joints or sections.
  - 1. Moisten subbase to provide a uniform dampened condition at time concrete is placed;
  - 2. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping according to recommendations in ACI 309R;
  - 3. Screed and initial-float concrete surfaces with darby or bull float before excess moisture or bleed water appears on the surface;
  - 4. Protect concrete from cold or hot weather during mixing, placing, and curing; and,

5. All concrete walks and aprons shall be a minimum of 4 inches thick as shown on the drawings, with a turned down edge as detailed.
  - F. Evaporation Retarder: Apply to concrete surfaces if hot, dry, or windy conditions exist. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
  - G. Pavement Tolerances: Comply with tolerances in ACI 330.1, Specification for Plain Concrete Parking Lots.
- 3.02 FINISHES AND CURING
- A. All exterior concrete shall receive a medium broom finish.
  - B. Curing: Begin curing after finishing concrete, but not before free water has disappeared from concrete surface. Cure concrete by one or a combination of the following methods:
    1. Moisture cure concrete by water, continuous fog spray, continuously wet absorptive cover, or by moisture-retaining-cover curing. Keep surfaces continuously moist for not less than 7 days; and,
    2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
  - C. All exterior concrete surface shall receive one coat of exterior sealer.
- 3.03 REPAIRS AND PROTECTION
- A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.
  - B. Protect concrete from damage. Provide adequate traffic control to prevent traffic from pavement for at least 14 days after placement.
  - C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than 2 days before date scheduled for substantial completion inspections.
- 3.04 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
  - B. ACI Publications: Comply with ACI 301R-99 and ACI330R-92, unless modified by the requirements of the Contract Documents.
  - C. The owner shall provide and pay for testing services. A slump test and air test shall be performed for each load delivered. Four standard test cylinders shall be taken for each 55 cubic yards of concrete or each days pour, whichever is more frequent. Two cylinders shall be broken at 7 days and two cylinders shall be broken at 28 days.



## SITE WORK CONCRETE MIX DESIGN SUBMITTAL FORM

Project: Bryan Mall High Rises renovation  
City: Clemson, SC  
General Contractor: \_\_\_\_\_  
Concrete Supplier: \_\_\_\_\_  
Concrete Strength (Class): \_\_\_\_\_  
Use (describe): \_\_\_\_\_

### DESIGN INFORMATION

Please check one

Based on Standard Deviation Analysis ☐  
Trial Mix Test Data ☐

### DESIGN CHARACTERISTICS

Density  pcf  
Strength  psi (28 day)  
Air  % specified

*If trial mixes are used the Mix Design is proportioned to achieve  $f'_{cr} = f'_c + 1200$  psi  
(1400 psi for strength higher than 5000 psi at 28 days)*

<u>MATERIALS</u>	Type/ Source	Specific Gravity	Weight/lb.	Absolute Vol. cu.ft.
Cement				
Microsilica				
Coarse Aggregate				
Fine Aggregate				
Water				
Other				
<b>TOTAL</b>				27.0 cu. ft.

\* Water/Cement Ratio (lbs. water/lbs. cement) = \_\_\_\_\_ %

<u>ADMIXTURES</u>	Manufacturer	Dosage oz/cwt
Water Reducer		
Air Entraining Agent		
High Range Water Reducer		
Non-Corrosive Accelerator		
Other		

Slump before HRWR \_\_\_\_\_ inches  
Slump after HRWR \_\_\_\_\_ inches

**Standard Deviation Analysis (from experience records):**

<b># of Test Cylinders Evaluated:</b>	
<b>Standard Deviation:</b>	

$$f_{cr} - f'_c + 1.34s \text{ or } f_{cr} = f'_c + 2.33s - 500$$

(Refer to ACI 301 for increased deviation factor when less than 30 tests are available)

***LABORATORY TEST DATA***

***Compressive Strength***

Age (days)	Mix # 1	Mix #2	Mix #3
7	psi	psi	psi
7	psi	psi	psi
28	psi	psi	psi
28	psi	psi	psi
<b>28 average</b>	psi	psi	psi

**REQUIRED ATTACHMENTS**

Coarse Aggregate Gradation Report  
Fine Aggregate Gradation Report  
Concrete Compressive Strength Data or Trial Mixture Test Data  
Admixture Compatability certification letter

Please Check


**Submitted by:**

Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
\_\_\_\_\_  
Phone #: \_\_\_\_\_  
Main Plant Location: \_\_\_\_\_  
Miles from Project: \_\_\_\_\_  
Secondary Plant Location: \_\_\_\_\_  
Miles from Project: \_\_\_\_\_  
\_\_\_\_\_  
Date: \_\_\_\_\_

END OF SECTION 32 16 00

**CONFORMANCE SUBMITTAL**  
**SECTION 32 16 00 – CONCRETE CURBS, GUTTERS, SIDEWALKS AND DRIVEWAYS**

Land Planning Associates,  
Inc. \_\_\_\_\_

General Contractor: \_\_\_\_\_  
(Company Name, Phone Number)  
\_\_\_\_\_  
(Address)

Sub-Contractor: \_\_\_\_\_  
(Company Name, Phone Number)  
\_\_\_\_\_  
(Address)

The following products have been selected (check one box) for use in this project from the list of acceptable products specified:

Exterior Concrete Sealant:

- ☐ Sonneborn “Kure-N-Seal 30” exterior acrylic sealer  
☐ Euclid “Super Rez-Seal

Cold-Applied Joint Sealant ASTM D5893, self leveling silicone sealant:

- ☐ Crafcro Inc. “Roadwaver Silicone-SL”  
☐ Dow Corning 888  
☐ Dow Corning 890-SL  
☐ Sonneborn “Sonomeric 1 Sealant”  
☐ Tremco “Vulkem 45”

Hot-Applied Joint Sealant: ASTM D3405, Polymeric sealant.

- ☐ Crafcro Inc. “ROADSAVER 22”  
☐ W.R. Meadows, Inc. “SEALTIGHT HI-SPEC”

I represent to Land Planning Associates, Inc. that the product selected will be installed in compliance with the applicable codes for the authorities having jurisdiction and in accordance with the contract documents. If noncompliance is discovered the General Contractor shall make or cause to be made all necessary corrections to meet the applicable codes and specifications. Immediately or as directed by the owner the work shall be completed without additional cost to the owner and / or the contract.

Sub-Contractor: \_\_\_\_\_  
(Signature of the Authorized Agent of the Sub-Contractor) Date  
\_\_\_\_\_  
(Print Name of the Authorized Agent of the Sub-Contractor)

General Contractor: \_\_\_\_\_

*(Signature of the Authorized Agent of the General Contractor)*

Date

---

*(Print Name of the Authorized Agent of the General Contractor)*

## SECTION 323113 - CHAIN LINK FENCES AND GATES

### 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. Procedures for compliance with certain "Green Globes for New Construction 2021," requirements may apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Chain-link fences.
  - 2. Swing gates.
  - 3. Privacy slats.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Fence and gate posts, rails, and fittings.
    - b. Chain-link fabric, reinforcements, and attachments.
    - c. Accessories: Privacy slats.
    - d. Gates and hardware.
- B. Shop Drawings: For each type of fence and gate assembly.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include accessories, hardware, gate operation, and operational clearances.
- C. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

- D. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Product Certificates: For each type of chain-link fence, and gate.
- C. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
- D. Sample Warranty: For special warranty.

## 1.6 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to comply with performance requirements.
    - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.
  - 1. Design Wind Load: As indicated on Drawings.

## 2.2 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
1. Fabric Height: As indicated on Drawings.
  2. Steel Wire for Fabric: Wire diameter of 0.192 inch.
    - a. Mesh Size: 2 inches.
    - b. Zinc-Coated Fabric: ASTM A392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied before weaving.
    - c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.
  3. Selvage: Knuckled at both selvages.

## 2.3 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:
1. Fence Height: 72 inches unless otherwise indicated.
  2. Light-Industrial-Strength Material: Group IC-L, round steel pipe, electric-resistance-welded pipe.
    - a. Line Post: 1.9 inches in diameter.
    - b. End, Corner, and Pull Posts: 2.375 inches.
  3. Horizontal Framework Members: Intermediate, top, and bottom rails according to ASTM F1043.
  4. Brace Rails: ASTM F1043.
  5. Metallic Coating for Steel Framework:
    - a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.

## 2.4 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire according to ASTM A817 or ASTM A824, with the following metallic coating:
1. Type II: Zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:

Retain one of first four subparagraphs below.

- a. Matching chain-link fabric coating weight.

## 2.5 SWING GATES

- A. General: ASTM F900 for gate posts and single or double swing gate types.
  - 1. Gate Leaf Width: As indicated.
  - 2. Framework Member Sizes and Strength: Based on gate fabric height of 72 inches or less.
- B. Pipe and Tubing:
  - 1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
  - 2. Gate Posts: Round tubular steel.
  - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded or assembled with corner fittings.
- D. Hardware:
  - 1. Hinges: 180-degree outward swing.
  - 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
  - 3. Lock: Manufacturer's standard internal device.

## 2.6 PRIVACY SLATS

- A. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch thick, sized to fit mesh specified for direction indicated, with vandal-resistant fasteners and lock strips.
- B. Color: As selected by Architect from manufacturer's full range.

## 2.7 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.



## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

### 3.3 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.
  - 1. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
    - b. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
    - c. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at 10 feet o.c.
- F. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
  - 1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
- G. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- H. Intermediate and Bottom Rails: Secure to posts with fittings.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.
- K. Privacy Slats: Install slats in direction indicated, securely locked in place.
  - 1. Diagonally for privacy factor of 80 to 85.

### 3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

### 3.5 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

- B. Lubricate hardware and other moving parts.

END OF SECTION 32 31 13

## SECTION 32 49 10 - MISCELLANEOUS SITE STONEWORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Stone drip strips.

- B. Related Sections:

- 1. Section 31 20 01 "Site Earth Moving" for excavation for installation of concrete footings, aggregate base course, drainage stone, and preparation of subgrade.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

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

- B. Samples for Verification:

- 1. 1/2 gallon of rounded riverbed gravel for each size indicated.
  - 2. For each variety of stone showing color and finish of stone required; not less than 12 inches square.

#### 1.5 QUALITY ASSURANCE

- A. Stone Observation: Architect will select stone for stone-check dam application at quarry or stone supplier's yard.

- 1. Arrange with Architect a time for selecting stone.

- B. Stake-out Observation: Architect will review stake-out of stone check dam layout. Architect retains the right to adjust final locations.

- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Build mockups of stone-check dams where indicated by Architect and not less than 10 feet long.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

#### 1.7 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Source Limitations for Stone: Obtain stone for rubble from single quarry or source with resources to provide materials of consistent quality in appearance and physical properties.

#### 2.2 STONE FOR DRIP STRIPS

- A. Stone: Natural, rounded gravel or smooth-faced stone, washed free of loam, sand, clay and other foreign substances:
  - 1. Color Range: Gray and buff.
  - 2. Sizes: 1-1/2" to 3".

#### 2.3 STONE AGGREGATE

- A. Drainage Aggregate: Washed crushed stone, or crushed or uncrushed gravel; size to be 1"-1-1/2".
- B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.

- C. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

## 2.4 AGGREGATE BASE

- A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with requirements in Section 31 20 00 "Earth Moving" for base course.

## 2.5 GEOTEXTILE

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, manufactured for subsurface drainage applications; complying with AASHTO M 288 and the following:
  - 1. Survivability: AASHTO M 288, Class 1.

## 2.6 EDGE RESTRAINT

- A. Edge Restraint: 6" by 1/4" steel with steel stakes at 36".

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates, adjoining construction and conditions under which the Work is to be installed. Do not proceed with Work until unsatisfactory conditions are corrected.

## 3.2 PREPARATION

- A. Layout stone aggregate at locations directed by Architect. Review locations with Architect on site and readjust as required. Obtain Architect's acceptance before final installation.

## 3.3 INSTALLATION OF STONE DRIP STRIP

- A. Install geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends at least 12 inches.
- B. Provide edge restraints as indicated.
  - 1. Install spikes at intervals required to hold edge restraints in place.
- C. Apply average thickness of riverbed gravel mulch over whole surface as indicated in Drawings, and finish level with adjacent finished grades.

### 3.4 EXCESS MATERIALS AND WASTE

- A. Excess Masonry Waste: Remove excess clean masonry waste and legally dispose of off Owner's property.

END OF SECTION 32 49 10

## SECTION 32 84 00 – LANDSCAPE IRRIGATION

### PART 1 - GENERAL

#### 1.1 SUMMARY OF WORK

- A. Provide all materials, labor, installation equipment, and technical service to complete construction of automatic irrigation system as well as the testing and warranty of the system as defined in this Specification and Construction. Items of work specifically included are:
  - 1. Procurement of all applicable licenses, permits, and fees.
  - 2. Coordination of all utilities.
  - 3. Verification of site conditions.
  - 4. Maintenance during guarantee period.
  - 5. Connection of electrical power supply to the irrigation control system.

#### 1.2 QUALIFICATIONS

- A. Qualified irrigation system installers must have a minimum experience of five (5) years with work and products specified herein, including:
  - 1. Weather-Based and Smart Controllers
  - 2. Commercial/Municipal Irrigation Systems
  - 3. Attest qualifications below for three (3) recent projects in the last five (5) years:



<b>Bidding Irrigation Contractor Qualifications Form</b>					
This Form Must be Filled Out Completely and Reviewed by Owner's Representative for Approval					
Installing Contractor Company Name:					
Company City, State:				Company Founding Date:	
<b>Project Reference #1</b>		<b>Project Reference #2</b>		<b>Project Reference #3</b>	
Project Name:		Project Name:		Project Name:	
City, State:		City, State:		City, State:	
Contact Name:		Contact Name:		Contact Name:	
Phone Number: (    )		Phone Number: (    )		Phone Number: (    )	
Project Description (Check All That Apply)		Project Description (Check All That Apply)		Project Description (Check All That Apply)	
<input type="checkbox"/>	Commercial or Institutional	<input type="checkbox"/>	Commercial or Institutional	<input type="checkbox"/>	Commercial or Institutional
<input type="checkbox"/>	Submittal & RFI Process	<input type="checkbox"/>	Submittal & RFI Process	<input type="checkbox"/>	Submittal & RFI Process
<input type="checkbox"/>	Green Roof or On-Structure	<input type="checkbox"/>	Green Roof or On-Structure	<input type="checkbox"/>	Green Roof or On-Structure
<input type="checkbox"/>	Two-Wire & Decoders	<input type="checkbox"/>	Two-Wire & Decoders	<input type="checkbox"/>	Two-Wire & Decoders
<input type="checkbox"/>	Weather, Flow, or Soil Sensing	<input type="checkbox"/>	Weather, Flow, or Soil Sensing	<input type="checkbox"/>	Weather, Flow, or Soil Sensing
<input type="checkbox"/>	Set-Up Internet Access	<input type="checkbox"/>	Set-Up Internet Access	<input type="checkbox"/>	Set-Up Internet Access
<input type="checkbox"/>	Solvent-Weld or Gasket Pipe	<input type="checkbox"/>	Solvent-Weld or Gasket Pipe	<input type="checkbox"/>	Solvent-Weld or Gasket Pipe
<input type="checkbox"/>	Drip Systems	<input type="checkbox"/>	Drip Systems	<input type="checkbox"/>	Drip Systems
<input type="checkbox"/>	Domestic Water Source	<input type="checkbox"/>	Domestic Water Source	<input type="checkbox"/>	Domestic Water Source
<i>By signing below, you, as irrigation installer contractor attest that the qualifications provided above are accurate, acknowledge reviewing this specification and drawings in full, and can meet all insurance requirements provided in Division 01 - General Requirements</i>					
Signature				Printed Name & Title:	
				Signature Date:	

### 1.3 WORK NOT INCLUDED (PROVIDED BY OTHERS)

- A. Domestic Water Service Point of Connection
  - 1. New building domestic water service to be provided by Plumbing Contractor. Refer to Division 22 PLUMBING. Approximate exterior point of connection location is noted on Construction Drawings.
    - a. Equipment requirements, must meet all local codes and provide adequate service flow as specified below. Required equipment includes at a minimum:
      - 1) Backflow Preventer
      - 2) Water Meter (Sewer Abatement)
      - 3) Domestic Water Connection
    - b. Flow and pressure requirements at outdoor point of connection:
      - 1) Flow: Maximum 2 gallons per minute
      - 2) Pressure: Not Applicable—make-up refills rainwater harvesting system
- B. Electrical Power Source to Indoor Controller
  - 1. New electrical circuits to be provided by Electrical Contractor (Refer to Division 26 ELECTRICAL).
    - a. Power Requirements for Irrigation Controller
      - 1) 120-Volt, 1-Phase, 60-Hz, 20-Amp
    - b. Power Requirements for Rainwater Irrigation Pump
      - 1) 120-Volt, 1-Phase, 60-Hz, 0.75-horsepower
    - c. Conduits to exterior point of connection
      - 1) Comply with all applicable building codes. Minimum Schedule 80 PVC with Long Sweep Elbows.
- C. Communications to Indoor Irrigation Controller
  - 1. Communications to be provided by Communications Contractor (Refer to Division 27 COMMUNICATIONS).
    - a. Communication Requirements for Irrigation Controller
      - 1) Ethernet CAT/5 Cable to Local Area Network
- D. Pipe Sleeves
  - 1. Pipe sleeves to be provided by Site Contractor beneath all roof deck pavers, as indicated on Construction Drawings.
    - a. Pipe sleeve requirements
      - 1) Two (2) parallel 4-inch Schedule 40 PVC
      - 2) Extend 18 inches beyond edge of hardscape
      - 3) Minimum cover: 24 inches

### 1.4 RELATED REQUIREMENTS

- A. Coordinate with other project trades and refer to overall project Construction Document

Specifications and Drawings, including, but not limited to:

1. Division 01 – General Requirements
2. Division 02 – Existing Conditions
3. Division 22 – Plumbing
4. Division 26 – Electrical
5. Division 27 – Communications
6. Division 32 – Exterior Improvements
7. Division 33 – Utilities
8. Construction Drawings:
  - a. L-100 Layout and Materials Plan
  - b. Review all other Project Construction Documents for coordination.

#### 1.5 APPLICABLE STANDARDS AND CODES

- A. At a minimum, comply with the following standards and codes:
  1. American Society for Testing and Materials (ASTM)
  2. National Standard Plumbing Code (NSPC)
  3. National Electric Code (NEC)
  4. National Sanitary Foundation (NSF)
  5. Underwriters Laboratories, Inc. (UL)
  6. Occupational Safety and Health Administration (OSHA)
- B. Comply with applicable laws, standards, and regulations of the local governing authority. All local laws more stringent than those referenced above shall take precedent.

#### 1.6 SUBMITTALS

- A. Submit the following under provisions of Section 01 33 00 - SUBMITTAL PROCEDURES:
  1. Literature: Manufacturer's product data sheets, specifications and installation instructions for materials listed in this Specification (Part 2 – Products).
    - a. Product submittals shall be concise (no extraneous pages or sections) and clearly marked to show submitted product model, type, size, etc.
    - b. Substitute Product Submittal:
      - 1) Provide specified product submittals for “an approved equal” to Owner’s Representative for approval.
      - 2) Alternate products are acceptable when products of equal or better quality and performance are submitted and approved by the Owner’s Representative.
      - 3) Substitute Product Submittals constitute representation that:
        - a) Substitute products have been thoroughly investigated and have been determined to be equal or superior in all respects to that specified.
        - b) Substitute products shall provide the same warranties as specified products.
        - c) Substitute products are compatible with interfacing items.

- d) Assume responsibility of and guarantee system performance as a result of product substitution, including making all subsequent changes to meet design specifications.
- c. Work shall not commence until all products specified are submitted and approved in a written notification by Owner's Representative.
- d. All product installed shall be new, without defects, and of quality and performance as specified.
- 2. Schedule: Submit Schedule of all products to be furnished hereunder, indicating manufacturer, size, and model.
  - a. Ensure that all of the types/styles of products and installation equipment specified herein can be furnished by the manufacturer submitted.
  - b. Provide all spare irrigation parts as noted (see Spare Irrigation Parts)
  - c. Prior to submitting schedule, confirm current site conditions are as provided in the Construction Drawings.

#### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver materials to the site, until all specified submittals have been submitted to, and approved by, the Owner's Representative.
- B. Coordinate with Owner's Representative for temporary storage and staging areas.
- C. Protect materials from damage from construction traffic, weather, corrosion, and other causes while stored on-site. Minimize on-site storage as possible.
- D. Store and handle all products and materials in compliance with manufacturer instructions and recommendations.

#### 1.8 GUARANTEE AND REPLACEMENT

- A. Guarantee entire irrigation system, parts and labor, for one (1) year from official written date of acceptance by Owner's Representative. Provide written warranty showing date of completion and period of warranty prior to request for final payment.
- B. System malfunctions occurring during the guarantee period due to defective materials, poor workmanship, or improper adjustment shall be corrected to satisfaction of Owner's Representative at no additional cost to the Owner.
  - 1. Repair all defects within 10 days of notification from Owner or Owner's Representative.
  - 2. Repair defects with approved products.
- C. First-year spring system start-up and winterization shall be included in system guarantee.
- D. Manufacturer warranties shall be provided for all products and materials where such warranties are offered in published product data. Copies of manufacturer warranties are to be included in the Operations & Maintenance Manual (See Operation and

Maintenance).

## PART 2 - PRODUCTS

### 2.1 AUTOMATIC IRRIGATION CONTROLLER

- A. Controller
  - 1. Size: 12-Station Controller, Approximately 11 inches (tall) x 10 inches (wide) x 3.5 inches (deep)
  - 2. Construction: Electric with 120-Volt Input and 24-Volt Output, Plastic Enclosure
  - 3. Standards: UL-Listed, CE, C-tick, FCC, EPA WaterSense & Smart Watermark Approved
  - 4. Features: 2-Sensor Inputs, Pump/Master Valve Controls, Wi-Fi connection, Internal Transformer, Predictive Watering Adjustment, Flow Meter Detection and Alerts
  - 5. Manufacturer/Model: Hunter PRO-HC with Hydrowise; or Approved Equal.
- B. External Devices
  - 1. Flow Sensor
    - a. Manufacturer/Model: Hunter HC-FLOW; or Approved Equal
  - 2. Remote Control
    - a. Manufacturer/Model: Hydrowise Web-Based Software monitored and controlled.; or Approved Equal
  - 3. Soil Moisture Sensor Module (Optional)
    - a. Manufacturer/Model: Baseline, WaterTec S100 with Soil Moisture Sensor

### 2.2 WIRE

- A. Conventional Wire (From Irrigation Controller to Electric Zone Valves)
  - 1. Size: 14AWG Minimum
  - 2. Construction: Single Strand Solid Copper Conductor with PVC Insulation
  - 3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
  - 4. Standards: ASTM B-3, ASTM B-8
  - 5. Markings: Manufacturer, Rating, Size, and Type
  - 6. Manufacturer/Model: Paige Electric Model P7001D; Service Wire Company UF14, UF12; Regency Wire & Cable 14AWG, 12AWG; or Approved Equal.
- B. Wire Splices
  - 1. Type: Direct Burial Wire Splice Kit (All Components Intact)
  - 2. Construction: Lockable Plastic Tube, Pre-Filled with Insulation Gel
  - 3. Ratings: UL-Listed, NEC, Direct Burial and Submersion, up to 600-Volt Potential
  - 4. Manufacturer/Model: 3M DBY-6; Rain Bird DB Series; or Approved Equal.
- C. Wire Conduit
  - 1. Size: 1-Inch Minimum
  - 2. Construction: PVC, Solvent Weld

3. Ratings: Schedule 40
4. Fittings: Long Sweep Elbows
5. Manufacturer: Cresline; Certainteed, JM Eagle; or Approved Equal.

## 2.3 PIPE AND FITTINGS

### A. Polyethylene (PE) Pipe

1. Size: 1-inch Maximum (12 gallons per minute)
2. Construction: Polyethylene (PE) 3408
3. Ratings: Class 100, Type III, SDR 15, Class C
4. Standards: ASTM D-2239
5. Colors: Black
6. Fittings: PVC Insert (per ASTM D-2609) with Stainless Steel Clamps on Each Side (1 Clamp per side for Laterals, 2 Clamps per side for Mainline)
7. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark
8. Manufacturers: Oil Creek; Certainteed; JM Eagle; or Approved Equal. Insert Fittings: Lasco, Dura, or Approved Equal. Clamps: Oetiker, or Approved Equal

## 2.4 ELECTRIC ZONE VALVES

### A. Drip Zone Valve (Kit)

1. Size: 1-Inch
2. Construction: Plastic Diaphragm with Reinforced Nylon or Fiberglass Body
3. Ratings: 200 psi, Minimum Flow of 0.2 gpm
4. Features: Manual Bleed Screw, Flow Control, Pressure Regulation (to 40-45psi), and Stainless Steel Screen Filtration to 100 micron (150 mesh), lay filter on side in valve box to fit depth
5. Manufacturer/Model: Hunter ICZ; Rain Bird X CZ; or Approved Equal

### B. Master Valve (Optional)

1. Size: 1-Inch
2. Construction: Brass Globe Valve
3. Ratings: 220 psi
4. Features: Manual Bleed Screw, Flow Control, Pressure Regulation, and Filter
5. Manufacturer/Model: Hunter IBV-FS; or Approved Equal

## 2.5 ISOLATION VALVES

### A. Lateral Isolation Valve

1. Size: 1-Inch and Smaller
2. Construction: Bronze, Ball Valve
3. Ratings: 200 psi
4. Features: T-handle, Quarter Turn
5. Manufacturer/Model: Matco-Norca Model 759; or Approved Equal.

## 2.6 QUICK COUPLING VALVES

- A. Small Mainline Quick Coupling Valve
  - 1. Size: 1-Inch, Normally Closed
  - 2. Construction: Brass, Spring-Loaded Valve Seat, Key Engaged
  - 3. Ratings: 125 psi
  - 4. Features: 1-Inch NPT Inlet, ACME Key, Locking Vinyl Cover, Anti-Rotation Stabilization Wings
  - 5. Rubber Cover: Purple for Non-Potable Water
  - 6. Manufacturer/Model: Hunter HQ-44RC-AW-R; or Approved Equal.

## 2.7 MANUAL DISC FILTER

- A. Size: 1½-Inch MPT (Inlet and Outlets)
- B. Construction: Body, Plastic; Disc Filter, Polypropylene
- C. Ratings: 200 Mesh, Working Pressure up to 140 psi
- D. Manufacturers: Netafim, Model 1½-Inch Long, or Approved Equal

## 2.8 VALVE BOXES

- A. General
  - 1. Install valve boxes on Capillary Fabric—Do not penetrate Capillary Fabric
  - 2. See Construction Drawings for Specific Brands and Sizes
  - 3. Size:
    - a. 12-Inch Standard Valve Box Extension (6-inches Deep Maximum)
      - 1) Single 1-Inch Drip Kits (laying filter on its side)
    - b. 6-Inch Round (Cut Depth as needed to match 6-inch Maximum Depth)
      - 1) Isolation Valve
      - 2) Quick Coupling Valve
  - 4. Construction: Resin
  - 5. Ratings: Tensile Strength 3,000-5,000 psi
  - 6. Lid Color: Black (or per Owner's Representative)
  - 7. Features: Lockable, Bolt-Down Covers, Brick Supported

## 2.9 DRIP IRRIGATION

- A. Integral Emitter Drip Tubing
  - 1. Type
    - a. Planter Beds
      - 1) Tubing: 16mm
      - 2) Emitters:
        - a) Rate: 0.4 gph
        - b) Spacing: 12-Inches
      - 3) Installation Spacing: See Construction Drawings

2. Construction: Polyethylene (PE) with Embedded Pressure Compensating Emitters
  3. Fittings: Insert Fittings at Headers, Corrosion Tubing Stakes to Secure Drip Tubing to Ground
  4. Manufacturer/Model: Netafim TLDL, or approved equal.
- B. Automatic Flushing Valve
1. Size: 1-Gallon Flush
  2. Construction: Plastic
  3. Fittings: 17mm PVC Barbed Fittings
  4. Manufacturer/Model: Netafim TLFV-1; or Approved Equal

## 2.10 EARTH MATERIALS

- A. Stone (in Valve Boxes)
1. Type: ¾-Inch (minimum) Crushed Stone
  2. Place on top of Capillary Fabric, do not penetrate Fabric layer

## 2.11 SPARE IRRIGATION PARTS

- A. Wrenches, Keys, and Tools for Servicing and Adjusting Drip System
- B. Quick Coupler Valve Keys (1)
- C. Gate Valve (1)
- D. Drip Zone Valve Kit (1)
- E. PVC Insert Dripline Fittings (6 Elbows and Tees)
- F. Integral Emitter Drip Tubing (100' Roll)

# PART 3 - EXECUTION

## 3.1 GENERAL

- A. Competent superintendents and assistants shall be on-site at all times during product delivery, installation, testing, and system adjustments.
1. Field communication by Owner or Owner's Representative to superintendent shall be binding.
- B. System features shall be laid out as indicated on Drawings, making minor adjustments for variations in planting arrangements or field conditions. Major changes shall be reviewed with Owner's Representative before acceptance.
1. Irrigation lines shown on Construction Drawings are diagrammatic only. Location of irrigation equipment is contingent upon and subject to integration with all other underground utilities, planting and hardscape design elements.

## 3.2 EXAMINATION

- A. Review and verify project conditions are as indicated on Construction Drawings prior to starting work, including but not limited to:
1. Utilities provided by Others
  2. Site grades and dimensions
  3. Landscaping and features



- 4. Structures
- 5. Pipe Sleeves
- 6. Roof Drainage System
- 7. Mechanical Wall Spaces
- B. Report any irregularities of site conditions to the Owner's Representative prior to beginning work.
- C. Beginning of installation connotes acceptance of existing project conditions.

### 3.3 PROJECT COORDINATION

- A. Coordinate with Owner's Representative to expeditiously install system.
- B. Provide written notifications (electronic is acceptable) to Owner's Representative prior to work commencement, weekly for progress report, for any proposed changes to system design, and upon installation completion.
- C. All questions of design intent, proposed design changes, field notifications, and product substitution after installation commences shall be in writing to Owner's Representative as a Request for Information (RFI).
- D. Utility Coordination:
  - 1. Maintain 6-inch minimum clearance between irrigation lines and any utility line. Do not install irrigation lines directly above another utility of any kind.
  - 2. Exercise care when installing irrigation elements near existing utilities.

### 3.4 SITE PROTECTION

- A. Protect landscaping, paving, structures, walls, footings, etc. from damage caused during work. Damage to work of another trade shall be reported at once.
- B. Replace or repair any damage with same product or material, to the satisfaction of Owner's Representative at no additional cost to the Owner per Guarantee.

### 3.5 PIPE INSTALLATION

- A. PE Lateral Pipe Preparation
  - 1. Cut PE pipe with pipe cutter, removing all burrs at cut ends. All pipe cuts are to be square and true.
  - 2. Clean ends as per manufacturer instructions.
  - 3. Push PE pipe through stainless steel clamp—do not clamp at this point.
  - 4. Soften PE pipe in hot water as per manufacturer recommendations for insert barbed fittings. If a propane blowtorch is used to soften PE ends for fittings, assume responsibility for and warranty all PE pipe to same level as manufacturer.
  - 5. Do not use lubricants or pipe dope with PE pipe.
  - 6. Insert barbed fittings fully and position stainless steel clamp over barbs. At this time, crimp or screw worm gear clamps down with appropriate tools to secure pipe and fitting.
  - 7. Where PE Mainline is proposed, use TWO (2) CLAMPS per fitting.
- B. Pipe and wire shall run along same path as mainline, at the elevation of the pipe invert

(See Wire Installation).

- C. Pipe Cover (unpaved surfaces, where depth is available):
  - a. PE Pipe = 4 inches (in green roof landscape)
  - b. Install Pipe on or above Capillary Fabric Layer—Do Not Penetrate Fabric Layer
- D. Pipe Protection:
  - 1. Prevent foreign material from entering pipe during installation.
  - 2. Open ends of pipe shall be closed by watertight plug or seal when not in use.
  - 3. Securely store pipe when not scheduled for installation.
  - 4. Pipe shall not be installed when water is in trench, during rainstorms, or when temperature is below 40 °F.
    - a. No additional pipe may be installed or backfilled if water enters trench during pipe installation. Remove all water from trench before resuming installation.
    - b. Pipe installed at temperatures below 40 °F shall be removed and replaced at no cost to owner.

### 3.6 PIPE SLEEVE INSTALLATION

- A. Coordinate with Owner's Representative for provided pipe sleeves and locations installed by Site Contractor.
- B. New Pipe Sleeves:
  - 1. Pipe Sleeve Cover: 2 inches under paver system
  - 2. Install pipe sleeves where irrigation pipe runs under hardscape.
  - 3. Extend pipe sleeves minimum 6 inches beyond edges of hardscapes.
  - 4. Prior to installation of pipe, pipe sleeve ends shall be field marked to allow field location during irrigation system installation.

### 3.7 ELECTRIC ZONE VALVE INSTALLATION

- A. Install all Schedule 80 PVC threaded nipples with Teflon tape, isolation valves, and/or union couplings in and out of electric zone valves as required.
- B. Set valves plumb with adjusting handle and all bolts, screws, and wiring accessible through valve box opening.
- C. Install within valve box to meet finish grade.
- D. Install specified valve box over all electric zone valves. Ensure lid is flush with final proposed grade (coordinate with Site Contractor).
- E. Adjust zone valve operation after installation using flow control device on valve.

### 3.8 ISOLATION VALVE INSTALLATION

- A. Install isolation valves as required.
- B. Install all exterior isolation valves on level crushed stone base for operation ease with appropriate valve wrench. Do not pour stone around valves that are already installed.
- C. Install specified valve box over all isolation valves. Ensure lid is flush with final

proposed grade (coordinate with Site Contractor).

- D. Check and tighten valve bonnet packing before valve box and backfill installation.

### 3.9 QUICK COUPLING VALVE INSTALLATION

- A. Install quick coupling valves as required; generally, at ends of mainline branches and immediately downstream of filter for winterization.
- B. Mount mainline quick coupling valves on 1-inch diameter standpipe and compact with stone in valve box with stabilizers.
- C. Where mainline pressure exceeds 60 psi, install pressure regulating valves to 40 psi off quick coupling valve service tee.

### 3.10 WIRE INSTALLATION

- A. Install wiring per local codes for less than 30-Volt service.
- B. Install valve wire alongside mainline at invert elevation. Backfill carefully to avoid any damage to wire insulation on conductors.
- C. Maintain sufficient slack for expansion, contraction and servicing. Do not install wiring tightly.
  - 1. Provide 30 inches slack.
  - 2. Provide sufficient length of wire in valve boxes to allow valve splice and all connections to be brought above grade for servicing.
  - 3. Coil slack for neatness in valve box.
- D. Provide waterproof splices at all in-ground wire connections using approved splice kits. All splices shall be made in valve boxes and recorded on Record Drawings.
- E. Provide complete wiring diagram showing wire routing for connections between controller and valves as specified in Record Documents.
- F. Securely store wire when not scheduled for installation.

### 3.11 GROUND INSTALLATION

- A. Controller Grounding
  - 1. Connect bare copper 8WG wire to controller ground lug and connect to earth ground as directed by Electrical Contractor (example: copper pipe, building ground system).

### 3.12 DRIP IRRIGATION INSTALLATION

- A. Integral Drip Emitter Tubing (Planter Beds)
  - 1. Install tubing on high side of plants to ensure vertical and lateral water distribution.
  - 2. Install emitter tubing 4-inches from all planter bed edges, curbs, walls, and hardscape features.
  - 3. Level Ground Installation
    - a. Install emitter tubing in rows spaced at design spacing for level ground.
  - 4. Slope Installation

- a. Install emitter tubing in rows spaced at design spacing for top 2/3 of slope.
- b. Install emitter tubing in rows spaced at 1.5 times design spacing for bottom 1/3 of slope.
- c. Orient rows parallel to slope.
5. For every 4 feet of elevation difference within a drip zone, install check valve on supply header.
6. Provide pressure regulation as designed.
7. Secure emitter tubing with stakes every 5 feet to prevent shifting from compaction, slopes, and general operation.
8. Install Automatic Flush Valves on ends of PVC exhaust headers at farthest points and lowest elevation. Place flush valves in extensive landscape for maximum drainage from intensive landscape.

### 3.13 AUTOMATIC IRRIGATION CONTROLLER INSTALLATION

#### A. Controller

1. Install controller at TBD.
2. Wire valves and external sensors into controller through conduits and set proper programming.
  - a. Program “Cycle-Soak” feature for all zones with sloped or poorly draining soils.
  - b. Install and calibrate soil moisture sensors as per manufacturer instructions.
  - c. Optional soil moisture sensors are not required for each irrigation zone. Assign representative soil moisture sensors for similar zones, such as:
    - 1) Sun vs. Shade
    - 2) Lawn vs. Plantings
    - 3) Heavy vs. Light Soils
3. Using licensed electrical, wire controller to 120-Volt, 20-Amp electrical supply provided by Electrical Contractor.
4. Provide keys to Owner after final walkthrough.

#### B. Flow Sensor

1. Install Flow Sensor as required.
2. Provide straight pipe for Flow Sensor to reduce turbulence:
  - a. Upstream: 10 inches (10 times pipe diameter)
  - b. Downstream: 5 inches (5 times pipe diameter)
3. Wire Flow Sensor to Automatic Irrigation Controller as specified with waterproof connectors. Do not use splices between Controller and Flow Sensor.

#### C. Grounding

1. Coordinate with Electrical Contractor for acceptable indoor ground location (if available).

#### D. Soil Moisture Sensing Add-On Module

1. Mount Baseline WaterTec S100 to Wall—powered through 24-Volt output from

- Hunter irrigation controller.
- 2. WaterTec wire bundle shall be routed to Hunter controller, soil moisture sensor wire shall be wired to existing solenoid valve wire (see manufacturer installation instructions).
- 3. Soil moisture sensor shall interrupt normal irrigation schedule when soil is sufficiently watered (by rain or irrigation).

### 3.14 VALVE BOX INSTALLATION

- A. Furnish and install valve boxes as per valve schedule above for each valve, splice, or sensor.
- B. Finish elevation of all boxes shall be at grade.
- C. Provide level brick supports beneath valve boxes, where grade permits.
  - 1. For square/rectangular boxes, provide four (4) supports - one at each corner.
  - 2. For round boxes, provide three (3) supports equally spaced.

### 3.15 IRRIGATION SYSTEM TESTING AND ADJUSTMENTS

- A. Include all testing and adjustments in submitted bid price.
- B. System Flushing:
  - 1. Open electric zone valves and flush out irrigation system under full head of water before drip system components.
  - 2. Flush entire irrigation system after complete installation.
  - 3. Clogged emitters shall be remedied after completion of irrigation system.
- C. Testing:
  - 1. Test all pipe and valves for leaks at operating pressure. Repair all leaks and retest until leaks are remedied.
  - 2. Perform coverage test with Owner's Representative present. Operate electric zone valves for five (5) minutes minimum during coverage test. Readjust dripline components to attain proper coverage. Replace any equipment that does not meet specified standards.
  - 3. After testing, clean all equipment of debris during installation.
- D. Throughout guarantee period, adjust drip system components and ensure coverage due to settlement and landscaping operations.

### 3.16 RECORD DOCUMENTS

- A. Record (As-Built) Drawings
  - 1. Maintain and update Record Drawings with red-line markings as project progresses, including locations of:
    - a. Drip equipment and descriptions (tubing type, emitter flows, and type)
    - b. Valve Boxes and descriptions (valve type, zone numbers, splice, etc.)
    - c. All equipment installed with distinct symbols.
    - d. Pipe routing and tees.
    - e. Wire routing and splices.

2. Locations of installed equipment (valve, controller, sensors) shall be referenced by two permanent locations (swing ties) or GPS.
  3. Make all notes legible as work progresses, any new equipment added shall use distinct symbols denoting location.
  4. Record Drawings shall be used as basis of payment for work completed. Provide copies of red-lined set to Owner's Representative along with payment request.
- B. Record Documents
1. Record Documents shall be on-site at all times. Maintain record of the following as the project progresses:
    - a. Plumbing and Electrical permits (state whether or not required)
    - b. Materials Approved and approval date
    - c. Pressure Test results, testing personnel and testing date.
    - d. Materials delivered, Accepted, and Installed by whom and date.
    - e. Field Communications and Requests for Information (RFI)
- C. Prior to final punchlist, provide complete electronic and hard copy files of Record Drawings and Documents to Owner's Representative as part of project completion. All information must be complete and shall be added to submitted documents prior to acceptance.

### 3.17 OPERATION AND MAINTENANCE

- A. General
1. Bid price shall include up to four (4) hours of irrigation system overview and instruction with Owner and/or Owner's Representative.
- B. Operation and Maintenance Manual
1. Provide three (3) hard cover binders titled "Operation and Maintenance for Clemson University" prior to application for acceptance and final payment.
  2. Operation and Maintenance Manual shall include, but not be limited to:
    - a. Title Page and Table of Contents
    - b. One-Paragraph Written Description of Irrigation System
    - c. Manufacturers' Data and Cut Sheets of Equipment, including:
      - 1) Copies of all approved submittals
      - 2) Wire resistance readings to each electric valve at completion (for future troubleshooting)
      - 3) Recommended operating settings
      - 4) Recommended maintenance schedule
      - 5) Name, address, and telephone number of installer (for repairs, spring startup, and winterization during 1-year guarantee period)
      - 6) Irrigation program for periods without rain and recommended settings including, zone run time, days per week, cycle-soak, and rain sensor suspension.
    - d. Winterization and Spring Startup Instructions (after 1-year guarantee period)

- e. Guarantee Data
- f. Pockets with Folded Plans of:
  - 1) Final Record Drawing
  - 2) Controller Valve and Wiring System Diagram Drawing

### 3.18 SITE CLEANUP

- A. Remove all unused materials and equipment from project site safely and efficiently. Dispose of all unused materials legally - including construction debris and trash.
- B. Adjust ground, compact, and re-plant around irrigation dripline and trenches as necessary for proper angle and elevation.
- C. Fill all depressions, erosion rills, etc. with proper planting soil mix to ensure site drainage.

### 3.19 FINAL OWNER ACCEPTANCE

- A. Final Owner Acceptance of Irrigation System is predicated on:
  - 1. Complete system installation, adjustment, testing, and instructional overview.
  - 2. Submission of Operation and Maintenance Manuals to Owner's Representative.
  - 3. Proper Programming of Automatic Irrigation Controller.
  - 4. Completed and approved all punchlist items.
- B. Owner and/or Owner's Representative shall provide written notice (hard copy and/or electronic) for Final Acceptance. Date of Final Acceptance notice shall serve as start of 1-year Guarantee period as described above.

END OF SECTION 32 84 00

## SECTION 32 91 00 – PLANTING SOIL SYSTEM

### PART 1 - GENERAL

#### 1.1 GENERAL PROVISION

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

#### 1.2 SUMMARY

- A. Scope of Work: The work of this Section consists of all site preparation work and related items as indicated on the Drawings and/or as specified herein and includes, but are not limited to the following:

1. Evaluation of rough subgrade water infiltration.
2. Planting soil material acquisition.
3. Testing and analysis for specification conformance.
4. Inspection and testing of subgrade for preparation of subgrade.
5. Installation and placement of landscape underdrainage piping
6. Installation and placement of soils.
7. Decompaction of soils.
8. Final in-place testing of soils.
9. Coordination with other trades.
10. Clean-up.

- B. Related Sections: Carefully examine all of the Contract Documents for the requirements that affect the work of this Section. Other specification Sections that directly relate to the work of this Section include, but are not limited to, the following:

1. Section 02 22 10 “Demolition” for demolitions and salvaged materials.
2. Section 32 91 50 “Landscape Underdrain System” for drainage of planting beds.
3. Section 3 292 00 “Turfs and Grasses” for seed, sod and fine grading.

- C. Definitions:

1. Compaction: Compaction of the soil fabric is any force applied to the soil that reduces porosity and where 90 percent of all compaction can be accomplished with only three applications of force under optimum soil moisture conditions.
2. Bio-infiltration Basin: A type of Rain Garden that is designed to collect and store stormwater runoff within a soil matrix with a vegetative component to facilitate water infiltration into an accepting permeable subsoil. Indicated on the drawings as “Infiltration Meadow.”
3. Dry Soil: The condition of the soil at or below the wilting point of plant available water in which the soil is powdery and subject to blowing.
4. Frozen Soil: The point at which the soil water has frozen and the soil has become very hard and cloddy. Ice crystals can be seen in the pore spaces of the soil.



5. Field Capacity: The percentage of water remaining in a soil two or three days after having been saturated and after free gravimetric drainage has ceased.
6. Moist Soil: The condition of the soil in where it can be formed into a ball and maintain its shape. Deformation of the soil is difficult with hand pressure. Free water is not visible and is usually considered the point between the wilting point and field capacity of the soil.
7. Saturated: All the pore space within a soil is filled with water and the remaining water is under gravitational forces to drain through the profile.
8. Scarification: The loosening of the surface of a soil lift by mechanical or manual means to alleviate compaction of the soil surface. Depth of scarification is dependent on material and extent of compaction. Depths are noted within the specifications.
9. Subsoil: The soil horizon directly below topsoil that provides water holding and structural support to plants. Source of the majority of micro-nutrients.
10. Subgrade: The in-situ soil material that the planting soil will be installed upon.
11. Topsoil: The mineral surface layer of soil that exhibit obliteration of all of the original rock structure and must show the following: (1) an accumulation of humified organic matter closely mixed with the mineral fraction and not dominated by properties characteristic of subsurface horizons; (2) has reasonable tilth (biological, chemical and physical properties) to support plant growth; and have two or more of the following:
  - a. A bulk density of less than 1.5g/cc installed
  - b. Less than 15 percent by weight coarse fragments greater than 2mm
  - c. Identifiable structure between clods called peds, no massive structure
  - d. No contamination (i.e. Toxic weeds, chemicals, heavy metals, construction debris)
12. Wet Soils: Soil that is considered wet will easily be deformed by hand pressure, maintain their shape, and free water will be visible within the pore spaces. The water content at this soil condition is considered at field capacity or wetter.

D. Qualifications:

1. Analysis and Testing of Materials Qualifications: For each type of packaged material required for the work of this Section, provide manufacturer's certified analysis. For all other materials, provide complete analysis by a recognized laboratory made in strict compliance with the standards and procedures of the following:
  - American Society of Testing Materials (ASTM)
  - American Society of Agronomy
  - Soil Science Society of America
  - Association of Official Agricultural Chemists.
  - U.S Composting Council
2. Quality Assurance Qualifications: Work and materials shall meet the standards of the following references:
  - International Society of Arboriculture (ISA)
  - American Society for Testing Materials (ASTM)
  - Environmental Protection Agency (EPA)
3. Installer Qualifications: A qualified landscape installer whose work has resulting in successful establishment of exterior plants.

- a. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site who has at least 5 years experience with projects of similar scale and complexity.
  - b. The Landscape Contractor shall have experience in the proper and safe transportation and installation of soil material and plants.
  - c. The Landscape Contractor shall have adequate supervision, staff, equipment and experience needed to complete a project of this magnitude.
  - d. The Landscape Contractor shall prepare and present to the Landscape Architect required soil submittals, and their associated specified test results four to six months prior to the scheduled soil and plant installation.
  - e. The Landscape Contractor shall have at between 3 to 5 years experience in installing designed soil mixes for projects of similar size, composition and complexity.
4. Soil Mixing Contractor Qualifications:
- a. Shall be able to provide soil mixes that meet the specifications within tolerances assigned. Examples of projects that meet this requirement are golf course mixes and/or athletic field mixes.
  - b. Shall be able to produce enough consistently uniform soil material for the project to meet the scheduled demands.
  - c. The soil mixing contractor shall be engaged at least four to six months prior to scheduled soil installation to allow for sufficient time for material searches and initial planting mix approval. For spring planting soil submittals shall be initiated by December of the previous year, and for fall planting submittals shall be started by at least the end of May of the same year.
  - d. Owner or Landscape Architect shall have the right to reject any soil supplier.

### 1.3 SUBMITTALS

- A. Certificates: Provide all certificates for soil and soil amendment materials as required by federal, state or local regulations.
- B. Testing Intervals for Organic Amendments, Planting Soil Mixes: Test results shall be for items specifically listed within the charts of the PRODUCTS section in Part 2. Testing is required at the following intervals:
  1. Testing of the organic compost material: Test certificates required for producers of municipal yard waste composts or composted biosolids are described within this Section 32 91 00 Part 1 and shall follow criteria listed within Part 2 of this section. Testing results shall be dated within six months of proposed use.
  2. Submit clearly labeled samples of one (1) quart for the S3, S2, and two (2) quarts organic soil amendment (compost) materials for approval to the Soil Scientist. The Soil Scientist will order tests to ensure specification compliance and timely turn-around. Include the billing address and email address for the contractor who shall be billed directly and receive test result copies by the third party testing agency.

Agricultural Service Laboratory  
171 Old Cheery Road / Clemson, SC 29634  
Phone: 864-656-2068

Fax: 864-656-2069  
<http://www.clemson.edu/agsrvlb>

or

Craul Land Scientists, Inc.  
282 Whiteman Drive  
Centre Hall, PA 16828  
(c): 814-280-5127  
Email: [tcraul@craulland.com](mailto:tcraul@craulland.com)

3. After test results for the composted organic material have been accepted the Contractor shall create sample soil mixes for the S1 soil layers for the planting soil. mix and submit those samples to the Soil Scientist
  4. If there is a phased approach that consists of multiple planting seasons, the compost and S1 material only shall be retested at the beginning of each planting season. This is due to possible wide variation of compost quality from season to season.
  5. Incomplete samples or incorrectly labeled samples shall not be reviewed and delay the approval process.
- C. Test Procedures and Reporting: These tests conform to ASTM, ASA, and SSSA mythology. The compost and planting soil mixes will have the following tests conducted to determine acceptability:
1. Compost: Analyses using Penn State AASL test 3A without fecal coliform.
  2. Soil Mixes shall be tested using the S3, S2, S1 testing procedures listed on A.McNitt&Seren Soil Testing.

#### 1.4 QUALITY ASSURANCE

- A. Planting Soil QA: During the placement of planting soils, composite sample every layer of the planting soil mix delivered to the job site. For example, if three loads of S3 and 2 truckloads of S2 are delivered in a day; one composite sample of one (1) quart of each material type will be taken for a total of just 2 samples. Keep these samples on site for review by the Landscape Architect and Soil Scientist during the construction process. Label each sample with the Soil Supplier, planting soil layer, date of delivery, general location of where it was placed, and any other notations that would be relevant such as if it was raining that day or the planting soil was too wet or dry. If there are questions or concerns with a certain mix, the Landscape Architect or Soil Scientist will require the QA sample to be tested using the same testing agency as initial submittals.
- B. Samples: Planting soils requires a long lead time. Prior to ordering the listed materials, submit representative samples of the same organic batches and soil mixes that will be used to the Soil Scientist for testing, selection and approval. Do not order materials until the Owner's approval has been obtained. Schedule at least 2 months for soil ingredient search and initial submittal approval. Delivered materials shall closely match the approved samples.
1. Organic Amendment: sample of 2 quarts.
  2. Soil Mix: sample of 1 quart for each soil layer after mixing organic material and soil.

C. In-place Designed Soil Testing:

1. General planting soil installation for planting beds and tree pits outside of structural planting soils areas shall be tested by the Soil Scientist using a cone penetrometer with a  $\frac{3}{4}$ " cone or equivalent for approximately one point every 100 ft<sup>2</sup> at an interval after S2 layer installation and again after complete soil profile installation. The planting soil penetration resistance shall be uniformly increasing in density with depth, not exceeding 250 lbs/in<sup>2</sup> to a depth of 30 inches when the soil is moist. There shall not be any compacted dense layers within the soil profile. Specific penetration resistance rates are given in Part 2 of this section for each soil layer.
2. In-place Density Tests for soils prescribed under sidewalks and pervious paving surfaces shall be conducted for at least three tests of surface soil density per segment as noted on the drawings by a testing agency contracted by hardscape contractor. Only the surface that is to support pavement construction is to be tested. Density testing shall conform to ASTM standards using either ASTM D1556-07 or ASTM D6938-10 and shall be at 95% of Standard Proctor measured at below optimum moisture content (Do not compact planting soils at moisture contents above the "Optimum" line)
3. Soil moisture field testing can be completed using the hand pat method in which a handful of soil is rolled into a ball about the size of a golf ball and then bounced in the hand for three to four times. If a sheen of water appears on the surface of the ball of soil, it is too wet to work. The designed soil should remain in a ball without disintegrating when patted and should only deform with slight to moderate finger pressure. If the soil cannot be formed into a ball, then it is too dry.

D. Planting Soil and Compost Submittal Acceptance: Submittals for planting soil approval must have complete test results attached as specified for each soil, results shall be clearly marked for their corresponding soil layer, clearly labeled with the soil supplier's name, and receipt of soil samples by the Soil Scientist before review of the submittal can take place. Incomplete test results will not be reviewed delaying the approval process.

E. Soil Installation Acceptance: Notify the soil scientist at least 10 days in advance of date of soil placement. Inspection of the soil installation shall take place during placement of the S3 layer and imported subsoil (B horizon) while some of the subgrade is visible and another inspection during the placement of the S2 layer before placement of the S1 layer. Final inspection shall take place during S1 and topsoil (Ap horizon) installation.

F. Partial Acceptance: Acceptance of partial areas or portions of the total work may be granted at the option of the Landscape Architect only if the area to be inspected for acceptance is large, well defined and easily described. The Landscape Architect is not obligated to provide partial acceptance of the work.

1. The requirements of PART 3 – EXECUTION shall be applied to Individual areas or portions of the total work that are intended for partial acceptance.

G. Final Acceptance: Final acceptance shall be defined as the date after which the Landscape Architect and Soil Scientist determine that all work, including Punch List items has been satisfactorily completed.

## 1.5 PROJECT CONDITIONS, HANDLING AND STORAGE

- A. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.
- B. Sequence deliveries to avoid delay. On-site storage space is permissible only with written notice from Construction Manager. Deliver soil materials only after preparations for placement of planting soil have been completed.
- C. Install planting soil layers directly before planting is to commence. Do not install plantings soils so that they over-winter without vegetation. Failure to vegetate the planting soil or allowing partial planting soil installation allows for extensive erosion, compaction, and overall degradation of the planting soil system requiring extensive refurbishment before spring planting. See Section 32 92 00 – LAWN AND GRASS MIX PLANTING for cover crop.
- D. Protect all planting soil installation from compaction, erosion and degradation through contamination with construction debris, sediment or washings.
- E. Soil that is to be stockpiled longer than two weeks, whether on or off site, shall not be placed in mounds greater than six feet high. If soil stockpiles greater than six feet high are to be stored for more than two weeks, the contractor shall break down and disperse soil so that mounds do not exceed the six-foot height restriction or thoroughly mix the stockpile once a month.
- F. Vehicular access to the site is restricted. Prior to construction the Contractor shall submit for approval a plan showing proposed routing for deliveries and site access which shall include, but not limited to equipment movements and staging locations
- G. Soil materials shall be covered at least two weeks prior to installation to prevent excess moisture from saturating the soil stockpile. If in doubt of planting soil moisture use the gravimetric oven dry method as described in Soil Science Society of America, Methods of Soil Analysis, Part 1, 1986 at least two days prior to soil installation and maintain records of testing.
- H. Soil materials shall not be mixed, handled or hauled, placed or compacted when it is wet, as after precipitation, nor when frozen. Soil shall be handled only when the moisture content is approximately less than 8 percent by volume.

## PART 2 - PRODUCTS

### 2.1 SOIL LAYERS (HORIZONS):

- A. General
  - 1. All plant mix material shall fulfill the requirements as specified and be tested to confirm the specified characteristics as detailed below.
  - 2. Samples of blended plant mixes including mulch and compost materials shall be submitted by the Contractor for testing and analysis to the approved testing laboratory. Include verification testing of on-site sub soils. Comply with specific materials requirements specified.

- a. No base organic material or soil mixes shall be used until certified test reports by an approved agricultural chemist have been received and approved by the Landscape Architect and Soil Scientist.
    - b. If necessary, testing of the soil material components may be requested by the Soil Scientist to facilitate approval of the plant soil mix.
    - c. As necessary, make any and all plant soil mix amendments and resubmit samples until approved.
  3. The Landscape Architect and Soil Scientist may request additional testing by the Contractor for confirmation of mix quality and/or plant soil mix amendments at any time until completion if quality control samples deviate from the specifications and/or initially approved submittals.
- B. Planting Soil Supply:
1. In the event that any of the soil materials are not available from the supplier or are not in compliance with specifications herein, the Contractor shall obtain material from other suppliers, conduct tests specified herein to provide materials in compliance with these specifications.
  2. The Soil Scientist and Landscape Architect shall be notified of all soil mix substitutions or any problems with the planting soil supply.
- C. Planting Soils:
1. *Soil layer (S3):* Planting Soil Drainage Layer consisting of a 6-inch layer of material with a USDA Texture of coarse sand.
    - a. Soil reaction with a pH between 4.5 – 7.5.
    - b. The S3 layer within the Rain Gardens shall have a, uniformly increasing with depth, penetration resistance of < 250 lbs/in<sup>2</sup> after installation. No dense layers (+ 50 lbs/in<sup>2</sup> from background rate) are allowed.
    - c. There shall be no visible organic material present in this layer.
    - d. Material must meet the following particle size distribution

S3 Soil Layer Particle Size Distribution

Particle Size Class	Passing Sieve No	Range in Percent Passing ASTM F 1632-03
gravel	1"	100
fine gravel	10	95 – 100
very coarse sand	18	80 – 95
coarse sand	35	60 - 80
medium sand	60	10 – 40
fine sand	140	8 – 15
very fine sand	270	1 – 10
silt* (<0.05mm)		1 – 6%
clay* (<0.002mm)		0 – 4%
Chemical		
Organic Matter %	ASTM F 1647-02a	<0.25

pH	1:1 Water	4.5 – 7.5
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\*determined by hydrometer method in ASTM F1632-03 as percent of total soil.

2. *Soil layer (S2):* A variable thickness layer of material with a USDA Texture of coarse sand to loamy sand. This material is designed for both applications of basic planting soil and structural subsoil. The thickness of the S2 is dependent on the soil profiles for individual planting areas, underground obstructions and transition areas.
  - a. The S2 layer shall have a, uniformly increasing with depth, penetration resistance of < 250 lbs/in<sup>2</sup> after installation. No dense layers (+ 50 lbs/in<sup>2</sup> from background rate) are allowed.
  - b. Areas over 3:1 slopes shall receive fiber reinforcement at the rates listed in the mix equivalency table.
  - c. The particle size distribution shall be:

S2 Soil Layer Particle Size Distribution

Particle Size Class	Passing Sieve No	Range in Percent Passing ASTM F 1632-03
gravel	1"	100
fine gravel	10	95 – 100
very coarse sand	18	90 – 100
coarse sand	35	65 – 85
medium sand	60	
fine sand	140	
very fine sand	270	
silt* (<0.05mm)		
clay* (<0.002mm)		
Chemical		
Organic Matter %	ASTM F 1647-02a	<1
pH	1:1 Water	5.5 – 7.0
EC	1:1 paste	1.5 dS/m

\*determined by hydrometer method in ASTM F1632-03 as percent of total soil.

3. *Soil layer (S1):* Planting Soil Surface layer. A layer consisting of a 8 inch layer of material with a USDA Texture of sand to loamy sand. (must be tested to meet specs after compost is approved and added)
  - a. The soil specifications shall be that the minimum infiltration rate for planting soil areas stays above 5 cm/hour (2 in/hr) after installation.
  - b. The soil shall have soil moisture content less than 8% by weight for installation.
  - c. The S1 layer shall have a uniformly increasing with depth, penetration resistance of < 120 lbs/in<sup>2</sup> after installation. No dense layers (+ 25 lbs/in<sup>2</sup> from background rate) are allowed.
  - d. Areas over 3:1 slopes shall receive fiber reinforcement at the rates listed in the mix equivalency table.
  - e. Areas adjacent to the designated fire lane will receive TurfGrid® reinforcement of the S1 layer.

- f. The particle size distribution shall be:

S1 Soil Layer Particle Size Distribution

Particle Size Class	Passing Sieve No	Range in Percent Passing ASTM F 1632-03
gravel	1"	100
fine gravel	10	95 – 100
very coarse sand	18	90 – 100
coarse sand	35	65 – 85
medium sand	60	30 – 40
fine sand	140	
very fine sand	270	
silt* (<0.05mm)		
clay* (<0.002mm)		
Chemical		
Organic Matter %	ASTM F 1647-02a	4 – 8% (weight)
pH	1:1 water	5.5 – 6.8
EC	1:1 paste	1.5 dS/m
Phosphorous (P)	extract	20 – 100 ppm
Potassium (K)	extract	200 – 600 ppm
Cation Exchange (CEC)	extract	>10 Meq/100g

\*determined by hydrometer method in ASTM F1632-03 as percent of total soil.

D. Organic Amendment:

1. Composted Biosolid and municipal yard waste compost producers shall provide the heavy metal certificate of the material delivered as per EPA and NYDEC standards. Composted organic matter shall have the following criteria:



Criteria	Test Method	Acceptable Range
Type		Brewer's waste, well composted mushroom substrate, municipal yard waste or leaf mulches are acceptable. If meeting all of the criteria noted below
Carbon/Nitrogen Ratio		11:1 – 22:1
Degree of Maturity	Dewer Self Heating or	VI – V
	Solvita Maturity Index or	6 – 8
	CO2 Evolution	1.2 % C/day
Foreign Material	Dry wt.	< 1" dia. And < 2% (of total)
Organic Matter %	Dry wt.	25 – 75%
Reaction	1:1 water	5.5 – 8.0
EC	1:1 water	< 4 dS/m
Ammonium	extract	< 200 ppm
Nutrient Content	extract	Nutrients shall be present in appropriate agricultural and horticultural proportions to prevent ion antagonism.
Heavy Metals	extract	Concentrations of heavy metals shall meet EPA, state and local standards for applications to soils with human activity. Other regulations on human contact may apply.

E. Composted Bark Mulch Blanket:

This mulch is for use as an erosion protection for areas where bare planting soils are awaiting planting for more than 10 days. It protects against sheet erosion and degradation of the soil biology within the topsoil (Ap and S1) layers.

Type	Length	Description
Shredded Bark Mulch	2 to 3 inches	Composted shredded bark mulch, at least ground once without foreign material greater than 1 inch making up less than 5% of total volume.

F. Geofiber® Reinforcement:

1. Fiber Soils™ Firelane Reinforcement: Provide TurfGrids® 36MLGF 0.5 – 0.75" fiber reinforced S1 (topsoil) layer planting soil mix for the areas designated on the Drawings as "Fire Lane Reinforced Soil." The planting soils receiving this application could be various profiles.

2. Fiber reinforcement as supplied by:

Fiber Soils:  
P.O. Box 80198  
Baton Rouge, LA 70898  
Phone: (225) 757-9136  
Mobile: (225) 772-7436  
Fax: (225) 752-7975

- G. Planting Soil Mix Equivalency Table: The mix ratios are rough estimates based on usual components found in the area and their physical properties. Adjustments to the mix may be needed to achieve the required planting soil properties. The soils supplied must meet the criteria listed above.

PART 3 - Layer Designation	Base Material or Equivalent	Second Soil Mix Component	Third Soil Mix Component	Mix Percent (Volume)
S3 Layer	ASTM C33 Fine Aggregate, USGA straight sand, non-calcareous Masonry Sand	None	None	None
S2 Layer	Approved S3 material	sandy loam‡	None	75:25
		sandy clay loam‡	None	83:17
		loam‡	None	80:20
S1 Layer	Approved S3 material	sandy loam‡	Approved Compost	58:19:23
		sandy clay loam‡	Approved Compost	64:13:23
		loam‡	Approved Compost	62:15:23
S1 Layer Profile Fire Lane Reinforced	S1 planting soil mix	TurfGrids® 36MLGF	None	1 lbs/8 ft <sup>2</sup> ^

^TurfGrids shall be mixed into the installed S1 layer using a specified tiller

‡USDA Soil Textures

2.2 SOIL PROFILES

- A. SOIL PROFILES – The planting soil profile consists of 6 inches of S3 drainage layer (additional S1 material may be needed to meet final grade and allow for settlement), a S2 layer that is thickened or thinned between 0 and 24” to make up the soil profiles from a lawn profile of 12 inches total to 36 inches for trees and all transition profiles in-between. Structural soil profiles follow the same thicknesses as the tree profile except for mechanical compaction up to 95% of standard proctor.

## PART 3 - EXECUTION

### 3.1 COORDINATION

- A. *Pre-Installation Examination Required:* The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the Construction Manager in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means the Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Soil Scientist and Construction Manager.
- B. *Planting Soil Preparation:* Examine soil and remove foreign materials, stones over 1", and organic debris over 2" in length. Mix-in amendments as required by tests and as approved by the Soil Scientist. All preparation and mixing shall be accomplished when the soil moisture content is less than 8 percent by volume.
- C. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
- D. Stormwater system tests shall be conducted prior to S1 layer placement so as not to damage the final soil layer. Any erosion or gully damage to the planting soils during these tests shall be corrected prior to S1 layer placement and final grading.

### 3.2 EXCAVATION AND SCARIFICATION

- A. Excavation of the soils shall be accomplished to a depths noted for each soil profile area. All construction debris shall be removed from the planting areas prior to placement of the soil layers. Care shall be taken to avoid working the soil when it has 8 percent moisture content or above.
  - 1. *Excavation Depths:* (of the subgrade below final grade where applicable)
    - a. All areas shall be excavated to depths noted on the drawings for various soil profile depths. Soil profile depths are noted for specific locations on the drawings.
    - b. The underdrainage piping trench shall be 12 inches below the bottom of the S3 layer depth, or at a depth to provide positive flow to the outlet.
    - c. The transition soil profile areas shall be excavated down to 12 inches below final grade.
  - 2. *Subgrade pitch:* All subgrades shall be pitched toward the underdrainage with an average between ½ to 1 percent or about 1 inch fall per 10 feet.
  - 3. *Subgrade Terraces:* Slopes over 2.5:1 shall have the 95% Standard Proctor compacted subgrade terraced with a 12 inch riser and a minimum of 24 inch treads. The tread widths will be sized based on the final grade slope shape of the area.
    - a. Care must be taken not to induce dense interfaces within any of the soil that follow the slope.

- B. *Scarification of the Subgrade:* After the specified engineering compaction for the subgrade is accomplished, scarification must loosen the compacted surface of the subgrade following final rough grade to a depth of 4 to 6 inches prior to the designed soil placement.

1. Scarification on slopes 4:1 to 2.5:1 shall be parallel to the contour to provide adhesion for the designed planting soils and be a minimum of 3 inches high from ridge to trough.
2. For areas receiving (B) and (Ap) subgrade shall be loosened just prior to soil placement.

### 3.3 COORDINATED PLANTING SOIL SECTIONS

- A. Landscaping Underdrainage:

1. See SECTION 32 91 50 – LANDSCAPE UNDERDRAINAGE SYSTEM for specifications and installation procedures for filter fabric and cleanouts. Placement shall be coordinated with the CIVIL drawings.

- B. Steam Line Insulation:

1. Prior to soil placement whether fill material or planting soils, the underground steam lines shall be incased in 2B “¾ inch” stone in a thickness of at least 6 inches on the at least the top and sides of the pipe and wrapped with geotextile as noted in SECTION 32 91 50. (See Drawings)
2. Construct geotextile wrapped gravel filled chimney around manhole covers and vaults so that the gravel is exposed at the surface. See drawings. This will allow heat to be transferred to the atmosphere.

### 3.4 MIXING OF TOPSOIL

- A. The planting soil shall be mixed in a ball mill, tromel or tub mill fitted with proper screening and paddles. Windrowing or bucket mixing the materials is not acceptable, as it does not produce uniform mixing of the components.
- B. Mixing of the compost for the S1 layer (topsoil) shall be accomplished in the same manner as the other mixing procedures. The compost shall be moist, but not overly wet. Compost shall not be so wet as to have water squeezed out by hand or as dry as to be easily blown by wind.

### 3.5 PLACEMENT OF PLANTING SOIL

- A. Examination of Subgrade: The subgrade shall be examined by the Contractor prior to the start of soil placement and planting. Any deficiencies shall be noted and related to the Construction Manager in writing prior to acceptance of the subgrade by the Landscape Contractor:
- B. General Soil Placement Requirements: The following items shall apply to all areas of the project:
1. Complete all hardscape construction after installation of the S2 layer and/or clean scarified subsoil has occurred. Do not place S1 in areas subjected to continued construction traffic to reduce compaction remediation extents.
  2. Limit all traffic during construction to areas designated for hardscape placement.

3. Installation of planting soils shall be accomplished with small tracked equipment with less than 8 lbs/in<sup>2</sup> ground pressure. Back-blading is strictly forbidden as it will overly compact the planting soil. If planting soil has been kept dry and the subgrade is not saturated, installation of the designed planting soil can continue the day after a rain event, unless the subgrade is considerably saturated or has standing water.
4. The scarification of the planting soils shall be such that care is taken not to damage the hardscape.
5. The depth of the scarification shall be 2 to 3 inches. Deeper loosening may be required if compaction is extensive. Test with cone penetrometer.
6. After hardscape construction is complete, the S2 layer and Clean Subsoil shall be scarified to loosen compacted areas adjacent to where construction occurred. Penetration resistance shall not exceed 200 lbs/ft<sup>2</sup> except where noted. Resistance shall be uniformly increasing with depth.
7. Scarify any other areas that have been compacted prior to S1 layer or Topsoil placement.
8. Care shall be taken to maintain the separation between the designed soil layers. Do not mix the S1, S2 or S3 with adjacent layers. All excavations shall keep planting soil layers separate and backfilled in the reverse order of excavation.
9. The Contractor shall place barricades as required to prevent any unnecessary compaction of the planting soil from vehicles, equipment, or pedestrian traffic during construction and vegetation establishment. Any additional compaction of the planting soil must be loosened satisfactorily to meet penetration resistance specifications.
10. Penetration resistance shall not exceed 250 lbs/ft<sup>2</sup> within the S2 and the resistance for the S1 layer shall be less than 120 lbs/ft<sup>2</sup> except where otherwise noted (under pavement plantings). The planting soil shall be uniformly increasing in density with depth. There shall not be any compacted layers within the soil profile.
11. The soil shall be worked at moisture content below soil field capacity, or between 5 and 10 percent moisture by weight. The soil is too wet if it clumps in large clods or has surfaces with a polished appearance when tillage equipment is used. Planting soils shall never be moved or worked when wet or frozen.
12. Fire Lane Turf areas receive TurfGrid™ reinforced S1 layer.
13. Where applicable, place 24 inches of the S2 layer where the soil installation shall not exceed 6 inches lifts. The thickness of the S2 layer shall be thickened or thinned to maintain final grade and use as a transition to other soil profiles. Light foot traffic and tracked light equipment is allowable for placing the next lift and is needed to seat the soil layers within the profile thus reducing overall subsidence. A light scarification of the surface of each lift with hand tools is required to break up any compacted surface and eliminate any dense interface. Higher traffic areas will require greater amounts of scarification. Additional compaction is prohibited except where noted.
14. Remove all organic and coarse fragments over 1 inch in diameter in the topsoil surface. Care must be used when employing a powered renovator because topsoil will have difficulty meeting soil profile density specifications.
15. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compacted due to subsequent construction operations or weather conditions.

C. SOIL PROFILE 1 – Placement, Tree Soil:

1. Place the S3 drainage layer in one 6 inch lift. Installers' foot traffic shall suffice for compaction of this lift. No mechanical compaction is required or shall be allowed.

2. Adjust the depth of the S3 layer to accommodate placement of large trees (rootball depth 36 inches and deeper). Place trees with approval of the Landscape Architect.
  - a. There shall be a pedestal of compacted subgrade or S3 under each of the root balls. Compact this area to 90 percent of standard Proctor at below optimum moisture content then lightly scarify the pedestal surface. The tree pedestal shall be slightly higher in elevation than the surrounding subgrade to allow drainage away from beneath the rootball.
  - b. Place at least 3 inches of S3 material on the pedestal area to allow support for the rootball and assist with tree leveling.
  - c. Root flare of the tree shall be 1 to 2 inches above final grade.
3. Place the S2 layer to the depth shown on the drawings. Scarify the surface of each layer and lift.
4. Plant small trees and large shrubs after the S2 layer has been installed. S1 shall not be placed until all the trees and large shrubs have been installed.
  - a. Compact a rootball pedestal of S2 material to 90 percent of Standard Proctor at below optimum moisture then lightly scarify the pedestal surface.
  - b. Root flare of the tree shall be 1 to 2 inches above final grade.
5. Install the 8 inches of the S1 layer after all plantings have been completed.

D. SOIL PROFILE 2 – Placement, High Use Lawn:

1. Place the S3 drainage layer in one 6 inch lift. Installers' foot traffic shall suffice for compaction of this lift. No mechanical compaction is required or shall be allowed unless otherwise noted.
2. Place the S1 mix in a one 8 inch lift, ensuring that the soil is graded uniformly, then sod as per the specifications.
3. If the lawn is to be seeded, incorporate 3.1 CY/1000 ft<sup>2</sup> into the upper 2-3 inches using a roto-tiller in two perpendicular passes.
4. The Fire Lane and Access Turf areas will receive TurfGrids™ at the rate of 1 lbs/8 ft<sup>2</sup>.
  - a. After placing the correct soil profile, TurfGrids will be incorporated into the surface S1 layer.
  - b. Spread Turfgrids at an Application Rate of 1 LB / 8 SF to Specified Soil Profile. Turfgrids spread in specified area using Drop Spreader, Top Dresser, Modified StrawBlower, or Hand Spreading Application. Some Hand Raking may be required to obtain uniform coverage at specified addition rate.
  - c. Mix Turfgrids to 6" Depth with Rotary Mixer until uniform Fiber / Sand Composite is obtained. Typically, 2 Passes at Right Angles with recommended Rotary Mixer. Equipment recommendations include Rotodairon, Blecavator, or Colari. Achieve a homogenous mixture.
  - d. Compact Fiber Reinforced Sand to a minimum 95% Standard Proctor (ASTM D-698)

E. SOIL PROFILE 3 – Trees within Pavement: For areas designated Profile 3 (See Drawings):

1. Place the S3 drainage layer in 6 inch lifts over a properly scarified and pitched subgrade. Compaction of this lift shall consist of light tamping by the installers foot traffic. No mechanical compaction shall be allowed except where otherwise noted.
2. Place 24 inches of S2 material in 6 inch lifts Compact each lift to 90 percent of Standard Proctor below optimum moisture. DO NOT compact soils above optimum moisture content.
3. Scarify each lift surface before applying additional lifts to a depth of 1-2 inches. The final lift below the pavement shall compacted to 95% and shall not be scarified.
4. Place approved Geotextile on the S2 surface in the areas noted on the drawings before placing the gravel base layer for concrete or permeable pavement sidewalks. Ensure that the Geotextile is folded back onto the gravel base and away from the planting areas to contain the base course aggregate.

CONSTRUCTION NOTE: For all utility boxes, large rocks (over 24" dia.) and structures that will be placed completely within the designed soil shall require compacted pedestals at 95% of Standard Proctor to support the structures.

### 3.6 PROTECTION AND REPAIRS

#### A. General:

1. Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials. Landscape contractor shall be the only personnel allowed on areas where planting soil has been installed.
2. The contractor can and should consult with the Soil Scientist for specific erosion control measures on a site-by-site basis to best protect their work.
3. Within the installation warranty period repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compacted due to subsequent construction operations or weather conditions.
4. Scarify or remove and replace material to a depth as directed by the Owner or Landscape Architect; reshape and re-compact by only hand tamping at the prescribed moisture content.
5. When providing water to plants within designed sand based planting soils, provide adequate water directly to the rootballs of all plants using watering gators or drip irrigation directly on the rootballs. Monitor the rootballs and not the surrounding soils for moisture until full plant establishment.
6. High Use Lawn Establishment Irrigation Procedures: When irrigating turf sand based soils during the establishment period, it must be done to train turf roots to use the entire soil profile. Irrigate for one day equal to a week's water, then turn off the irrigation until the turf gets a brown cast showing water stress, then water again. Watering turf a little per day keeps the roots near the surface and does not train them to reach moisture deeper in the soil profile restricting root growth.
7. Where settling occurs, before sidewalk construction and final soil installation acceptance, backfill with additional approved material, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Owner.
8. Allow three to six weeks of completely restricted pedestrian traffic on all lawn areas to allow full turf establishment. The length of time of the restriction shall be based on weather conditions during the establishment period. Heavy drought conditions shall extend the

necessary establishment period. The turf must be fully knitted with the majority of roots six inches within the soil profile.

### 3.7 POST INSTALLATION SOIL MANAGEMENT

- A. Where settling occurs, backfill with additional approved material, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Owner.
  - 1. Any post installation changes or amendments to previously approved soils without the Landscape Architect or Soil Scientist's consent are the responsibility of the owner.
- B. Fertilization and/or application of Biologic Amendments of planting areas shall be completed based on soil tests taken 10 days after planting to determine the optimum types and rates.
- C. The following items are the responsibility of the Owner after the guarantee period to ensure the sustainability of the designed soil and plants for the life of site.
  - 1. Allow three to six weeks of completely restricted pedestrian traffic on all lawn areas to allow full turf establishment. The length of time of the restriction shall be based on weather conditions during the establishment period. Heavy drought conditions shall extend the necessary establishment period. The turf must be fully knitted with the majority of roots six inches within the soil profile.
  - 2. Take soil samples at least every two years to monitor soil pH, organic matter content, nutrients and/or biology (if needed) for trends that require management to maintain the plant health over time.
- D. *Long Term Turf Management:* To maintain the life of the turf within the lawn areas a policy of restricted use, resting times before and after large events, and mowing procedures should be implemented. Implementation of a lawn use policy will reduce annual turf renovation costs and reduce irrigation requirements.
  - 1. During the growing season, there shall be at least one day a week that the lawn is off limits to all use for general maintenance and turf recovery.
  - 2. Events shall be scheduled so that no more than two heavy uses per week are allowed. For every day of heavy use, 36 hours of recovery time use restrictions shall be employed. Drought conditions must reduce overall turf use.
  - 3. If the lawn is under water stress as during a drought, irrigate based on plant needs only to keep the turf leaves from folding, and do not mow the grass. Cutting the grass leaves opens the plant to excessive water loss. Timely irrigation to maintain turf color will cause deeper rooting and increase turf resistance to drought and heavy use.
  - 4. *Irrigation procedures:* To irrigate sand based soils must be done to train turf roots to use the entire soil profile. Irrigate for one day equal to a week's water, then turn off the irrigation until the turf gets a brown cast, then water again. Watering turf a little per day keeps the roots near the surface and does not train them to reach moisture deeper in the soil profile restricting root growth.
  - 5. Restrict all use during a drought unless the turf has been irrigated and rested for at least 36 hours before the event. Right after the event, the lawn should be closed and watered again for at least 48 hours.



### 3.8 WASTE MANAGEMENT

- A. Separate and dispose of waste in accordance with the projects Waste Management Plan.

## PART 4 - MEASUREMENT AND PAYMENT

### 4.1 GENERAL

- A. The Planting Soils will not be measured but will be paid for as part of the Base Contract Price (lump sum) and shall include furnishing all material, mobilization, labor, equipment, tools, and incidentals necessary to complete the work shown on the Drawings. No separate measurement or payment will be made for acquisition of permits, soil materials, equipment, material disposal, physical and chemical tests on imported materials (both initial submittals and QA testing), erosion controls, soil material protection, stockpiling, material rehandling, surveying, or other associated items or work considered incidental to the conduct the work of this Section.

END OF SECTION 32 91 00

## SECTION 32 91 15 - SOIL PREPARATION

### 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. Planting soils specified according to performance requirements of the mixes.
  - 2. Installation.
- B. Related Requirements:
  - 1. Section 33 46 00 "Subdrainage" for subdrainage for bio-retention beds.

#### 1.3 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

- I. Moist Soil: The condition of the soil when it maintains its shape when formed into a ball. Deformation of the soil is difficult under hand pressure. Free water is not visible. The condition also is considered the point between the wilting point and field capacity of the soil.
- J. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- K. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- L. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- M. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- N. SSSA: Soil Science Society of America.
- O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- P. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- Q. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- R. USCC: U.S. Composting Council.
- S. Wet Soil: The condition of the soil at which point it maintains its shape when formed into a ball but easily deforms under hand pressure. Free water is visible within the pore spaces. The water content in this soil condition is considered at field capacity or wetter.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include recommendations for application and use.
  - 2. Include test data substantiating that products comply with requirements.

3. Include sieve analyses for aggregate materials.
  4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
    - a. Manufacturer's qualified testing agency's certified analysis of standard products.
    - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.
1. Planting Soil: 2 lb of each planting soil mix required; in sealed containers labeled. Each Sample shall be typical of the lot of soil to be furnished.
    - a. Submit samples with Soil Analysis. Label planting soil mixes with mix percentages.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Soil Moisture Test Reports: For each soil. Test soil at least two days before installation.
- D. Field quality-control reports.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and plant establishment.
  1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  2. Experience: Five years' experience in the transportation and installation of planting soils in addition to requirements in Section 01 40 00 "Quality Requirements."
  3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Soil-Mixing Contractor Qualifications: A qualified soil-mixing contractor whose work has resulted in successful production of uniform planting soils, and capable of providing the volume of planting soil required for the Project within the specified tolerances.

- C. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
- D. Observations: Conduct the following site observations with the Architect. Notify Architect seven days in advance of review date.
  - 1. Review of subgrade preparation.
  - 2. Review of planting soil installation.
  - 3. Review of finish grade.

#### 1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on imported soil.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
  - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.
- C. Production Quality Soil Analyses: For each amended, blended soil mix type, perform testing on soil samples and furnish soil analysis to confirm that soil mix complies with requirements, one material test report for each 500 cubic yards from random samples.
  - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

#### 1.9 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by soil supplier/manufacturer under the direction of the testing agency.

#### 1.10 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
    - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
    - b. Hydrometer Method: Report percentages of sand, silt, and clay.
  2. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  3. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).
- C. Chemical Testing:
1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAFT NEC-67, including the following:
1. Percentage of organic matter.
  2. CEC, calcium percent of CEC, and magnesium percent of CEC.
  3. Soil reaction (acidity/alkalinity pH value).
  4. Buffered acidity or alkalinity.
  5. Nitrogen ppm.
  6. Phosphorous ppm.
  7. Potassium ppm.
  8. Magnesium ppm.
  9. Calcium ppm.
  10. Sodium ppm and sodium absorption ratio.
  11. Soluble-salts ppm.
  12. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
  13. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
1. Testing for Organic Matter in Planting Soil Mixes: Screen soil sample with a ¼-inch sieve.
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

#### 1.11 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Do not move or handle materials when they are wet or frozen.
  4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

### PART 2 - PRODUCTS

#### 2.1 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

- A. Planting-Soil Type A (Turf Areas): Manufactured soil consisting of manufacturer's basic sandy loam according to USDA textures, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials as specified in other articles of this Section to produce viable planting soil.
  1. Basic Properties: Manufactured soil shall not contain the following:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
    - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches in any dimension.
  2. Particle Size Distribution by Separates:

- a. Very Coarse to Medium Sand: 55 to 65 percent by dry weight.
    - b. Fine to Very Fine Sand: 10 to 20 percent by dry weight.
    - c. Silt: 15 to 35 percent by dry weight.
    - d. Clay: 10 to 20 percent by dry weight.
  3. Percentage of Organic Matter: 4 to 5 percent by dry weight.
  4. Soil Reaction: pH of 6.5 to 7.5.
  5. CEC of Total Soil: Minimum 10 meq/100 mL at pH of 7.0.
- B. Planting-Soil Type B (Non-Turf Areas): Manufactured soil consisting of manufacturer's basic loam according to USDA textures, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials as specified in other articles of this Section to produce viable planting soil.
1. Basic Properties: Manufactured soil shall not contain the following:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
    - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches in any dimension.
  2. Particle Size Distribution by Separates:
    - a. Very Coarse to Medium Sand: 55 to 65 percent by dry weight.
    - b. Fine to Very Fine Sand: 10 to 20 percent by dry weight.
    - c. Silt: 15 to 35 percent by dry weight.
    - d. Clay: 10 to 20 percent by dry weight.
  3. Percentage of Organic Matter: 8 to 10 percent by dry weight.
  4. Soil Reaction: pH of 6.5 to 7.5.
  5. CEC of Total Soil: Minimum 10 meq/100 mL at pH of 7.0.
- C. Planting-Soil Type C (Tree Trenches): Manufactured soil consisting of manufacturer's basic coarse sand to loamy sand according to USDA textures, blended in a manufacturing facility with stabilized organic soil amendments, and other materials as specified in other articles of the Section to produce viable planting soil.
1. Basic Properties: Manufactured soil shall not contain the following:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.



- b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
  - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches in any dimension.
2. Particle Size Distribution by separates with the following particle size distribution, based on ASTM F 1632:

<u>Particle Size Class</u>	<u>Sieve No.</u>	<u>Range in Percentage</u> <u>Passing</u>
Fine gravel	10	92 - 100
Very coarse sand	18	90 - 100
Coarse sand	35	65 - 85
Medium sand	60	30 - 40
Fine sand	140	15 - 25
Very fine sand	270	9 - 18
Silt*		6 - 12
Clay*		3 - 6

\*determined by hydrometer method in ASTM F 1632

- 3. Percentage of Organic Matter: Maximum 1 percent by dry weight.
- 4. Soil Reaction: pH of 5.5 to 6.5.

## 2.2 INORGANIC SOIL AMENDMENTS

- A. General: Comply with written recommendations of soil testing service for turf and plant applications.
- B. Sand: Clean, washed, natural or manufactured silica sand or non-calcareous material; free of toxic materials, and according to ASTM C 33/C 33M; and with the following particle size distribution, based on ASTM F 1632:

<u>Particle Size Class</u>	<u>Sieve No.</u>	<u>Range in Percentage</u> <u>Passing</u>
Fine gravel	10	92 - 100
Very coarse sand	18	75 - 89
Coarse sand	35	45 - 64
Medium sand	60	20 - 30
Fine sand	140	6 - 14
Very fine sand	270	3 - 9
Silt*		2 - 6
Clay*		1 - 3

\*determined by hydrometer method in ASTM F 1632

## 2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
1. Feedstock: Limited to leaves and yard waste.
  2. Reaction: pH of 5.5 to 6.5.
  3. Soluble-Salt Concentration: Less than 1.5 dS/m.
  4. Moisture Content: 35 to 55 percent by weight.
  5. Organic-Matter Content: 25 to 55 percent of dry weight.
  6. Carbon: Nitrogen Ratio: 11:1 to 22:1.
  7. Degree of Maturity: One of the following:
    - a. Dewer Self Heating: VI to V.
    - b. Solvita Maturity Index: 6 to 8.
    - c. CO<sub>2</sub> Evolution: 1.2 percent C/day.
  8. Ammonium: Less than 200 ppm.
  9. Heavy Metals and Other Pollutants: Not exceeding EPA and State's environmental protection agency standards for applications for human activity.
    - a. EPA, 40 CFR Part 503 Biosolids Rule, Section 503.13 Table 3 "Pollutant Concentrations."
  10. Nutrient Content: Containing some nitrogen, phosphorus, potassium, calcium, magnesium, sodium and micronutrients including iron, copper, boron, and manganese; nutrients shall be present in appropriate agricultural and horticultural proportions to prevent ion antagonism; by extract.
  11. Particle Size: Minimum of 98 percent passing through a 1/2-inch sieve.

## 2.4 FERTILIZERS

- A. General: Comply with written recommendations of soil testing service for turf and plant applications.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- B. Subgrades Compacted by Construction Activity: Loosen subgrade to a depth of 18 inches with vertical trenches 24 inches apart. Loosen subsoil in two directions at right angles to each other. Recompact at 85 percent.
- C. Compact subgrade to a maximum of 250 lbs/sq in to a depth of 12 inches, measured using a cone penetrometer with a  $\frac{3}{4}$ -inch diameter head.
- D. Proceed with placement only after unsatisfactory conditions have been corrected.

### 3.2 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Lifts: Apply planting soil in lifts not exceeding 6 inches in loose depth. Scarify the surface of each lift.
- D. Compaction: Compact planting soil to a maximum of 100 lbs/sq in within the top 6 inches of the soil profile, measured using a cone penetrometer with a  $\frac{3}{4}$ -inch diameter head.

- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.3 PLACING MANUFACTURED PLANTING SOIL IN TREE TRENCHES

- A. General: Apply planting soil Type C in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Lifts: Apply planting soil in lifts not exceeding 6 inches in loose depth. Scarify the surface of each lift.
- D. Compaction:
  - 1. Compact each lift to a maximum of 90 percent of Standard Proctor below optimum moisture.
  - 2. Compact final lift to 95 percent Standard Proctor.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
  - 1. Subgrade: Test subgrade soil density using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
  - 2. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
  - 3. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
- C. Soil will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

### 3.5 PROTECTION

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- B. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

### 3.6 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
  - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 32 91 15

## SECTION 32 91 50 – LANDSCAPE UNDERDRAIN

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, apply to the work of this Section and are hereby made a part of this Section.

#### 1.2 SUMMARY

- A. Scope of Work:

The work of this Section consists of all site preparation work and related items as indicated on the Drawings and/or as specified herein and includes, but are not limited to the following:

1. Testing and analysis for specification conformance.
2. Inspection and testing of subgrade for preparation of subgrade.
3. Preparation of mixes and testing for conformance.
4. Installation and placement of soils.
5. Coordination with other trades.
6. Clean-up.

- B. Related Sections:

Carefully examine all of the Contract Documents for the requirements that affect the work of this Section. Other specification Sections that directly relate to the work of this Section include, but are not limited to, the following:

1. Division 02 22 10 “Demolition” for demolitions and salvaged materials.
2. Division 32 91 50 “Landscape Underdrain System” for drainage of planting beds.
3. Division 32 92 00 “Turfs and Grasses” for seed, sod and fine grading.

- C. Definitions:

1. *Compaction*: Compaction of the soil fabric is any force applied to the soil that reduces porosity and where 90 percent of all compaction can be accomplished with only three applications of force under optimum soil moisture conditions.
2. *Dry Soil*: The condition of the soil at or below the wilting point of plant available water in which the soil is powdery and subject to blowing.
3. *Frozen Soil*: The point at which the soil water has frozen and the soil has become very hard and cloddy. Ice crystals can be seen in the pore spaces of the soil.
4. *Moist Soil*: The condition of the soil in where it can be formed into a ball and maintain its shape. Deformation of the soil is difficult with hand pressure. Free water is not visible and is usually considered the point between the wilting point and field capacity of the soil.

5. *Scarification*: The loosening of the surface of a soil lift by mechanical or manual means to alleviate compaction of the soil surface. Depth of scarification is dependent on material and extent of compaction. Depths are noted within the specifications.
6. *Subsoil*: The soil horizon directly below topsoil that provides water holding and structural support to plants. Source of the majority of micro-nutrients.
7. *Subgrade*: The in-situ soil material that the planting soil will be installed upon.
8. *Wet Soils*: Soils that are considered wet will easily be deformed by hand pressure, maintain their shape, and free water will be visible within the pore spaces. The water content at this soil condition is considered at field capacity or wetter.

D. Qualifications:

1. *Analysis and Testing of Materials Qualifications*: For each type of packaged material required for the work of this Section, provide manufacturer's certified analysis. For all other materials, provide complete analysis by a recognized laboratory made in strict compliance with the standards and procedures of the following:

American Society of Testing Materials (ASTM)
2. Quality Assurance Qualifications: Work and materials shall meet the standards of the following references:

American Society for Testing Materials (ASTM)
3. *Installer Qualifications*: A qualified installer whose work has resulting in successful projects.
  - a. *Installer's Field Supervision*: Require Installer to maintain an experienced full-time supervisor on Project site who has at least 5 years experience with projects of similar scale and complexity.
  - b. The Contractor shall have experience in the proper and safe transportation and installation of soil material.
  - c. The Contractor shall have adequate supervision, staff, equipment and experience needed to complete a project of this magnitude..
4. *Testing Laboratory Qualifications*: An independent laboratory, recognized by the State Department of Agriculture, with experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
  - a. Employ a qualified independent testing and inspection laboratory acceptable to the Civil Engineer, Soil Scientist and Owner to perform tests and certifications indicated.
  - b. It is the responsibility of Landscape Contractor in conjunction with the Soil Supplier to submit material for the soil and compost tests.
  - c. Tests shall be made in strict compliance with the standards of ASTM or AASHTO
  - d. Alternate Laboratories from list contained within the Planting Soil System Section require approval by the Soil Scientist

1.3 SUBMITTALS

- A. *Testing Intervals for Landscape Underdrainage System*: Supply all items listed. Incomplete documentation will not be reviewed delaying the approval process.
1. Submit sample, supplier and ASTM D-422 material particle size distribution for the *Landscape Underdrainage Filtration Gravel*. The sample shall meet AASHTO M-43 #7 or #78 specifications.
  2. Submittals for *Landscape Underdrainage Perforated Piping* approval shall use ASTM F-810 OR F-405 and have complete test results attached as specified. Certificates shall be clearly labeled with the supplier's name, and warranty data.
  3. Submittals for *Landscape Underdrainage Filter Fabric*: Submit sample, manufacturer, warrantee information and material data sheet for approval. See product specifications below.

## 1.5 PROJECT CONDITIONS

- A. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.
- B. Sequence deliveries to avoid delay. On-site storage space is permissible only with written notice from Owner. Deliver soil materials only after preparations for placement of Bioretention soil have been completed.
- C. Install Landscape Underdrainage System and cover with excess filter fabric to protect filtration gravel from sediment from other construction activities until the designed sand based soil is place. Then remove protective fabric from the filtration gravel before placing the S3 layer.
- D. Vehicular access to the site is restricted. Prior to construction the Contractor shall submit for approval a plan showing proposed routing for deliveries and site access which shall include, but not limited to equipment movements and staging locations

## PART 2 – PRODUCTS

### 2.1 LANDSCAPE UNDERDRAINAGE PIPE FILTRATION GRAVEL:

- A. The perforated underdrainage pipes shall require a minimum 4 inch gravel filtration encasement to protect the pipe from siltation from the overlying soil material.
- B. In order to best match the sand particle size and allow for laminar inflow of water, an AASHTO (M-43) gravel size of #7 or #78 is required.
- C. Underdrain gravel shall conform to the following specifications:

SIEVE OPENING	0.25 in.	to 0.5 in.	Pea gravel shall be clean double- washed crushed aggregate, free of
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SIZE SPECIFICATION	AASHTO M-43	rock dust, fines or soil particles and foreign material.
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- D. No filter fabric is to be used separating the gravel layer from the overlying sand layer. Standard filter fabric shall be used to line the drainage trench and used to temporarily cover the filtration gravel to prevent siltation from other construction until the planting soil is in place.

## 2.2 LANDSCAPE UNDERDRAINAGE PERFORATED PIPING:

- A. Landscape Underdrainage Piping: Landscape underdrainage piping will be placed in a 12"W x 12"D trench pitched >1% to the outlet within subgrade. Piping will be placed as noted in the Civil Engineer and Landscape Architect drawings.
- B. Other underdrainage piping can be substituted with the approval of the Soil Scientist. Other underdrainage systems require modification of installation procedures outlined within this Section. The Soil Scientist can assist in procedures and layout to meet the Planting Soil System functionality.
- C. Standard connections shall meet the requirements of the ASTM F405 or ASTM F667 for flexible corrugated plastic pipe.

STANDARD	MEETS ASTM F810 OR F405
SIZE	Schd 40 PVC (preferred) or 4", three (3) or six (6) slot, Corrugated Plastic Pipe without filter socks <sup>†</sup>
FITTINGS	4" 45° Elbows, End caps with covers, Schd 40 PVC or proper fittings for Corrugated Plastic Pipe
PERFORATION	¼" inflow holes @ 6" on center, located at the 4- and 8- o'clock position of the installed pipe

<sup>†</sup> See procedure in EXECUTION for use of Flexible Perforated Pipe.

## 2.3 LANDSCAPE UNDERDRAINAGE FILTER FABRIC:

- A. A drainage-type non-woven geotextile fabric shall be used as a separation layer to prevent the surrounding in-situ subgrade soil from migrating into the bio-retention system. The geotextile is to be used to line the entire trench excavation prior to placement of any filter soil, crushed stone and underdrainage piping. The permeability of the drainage fabric shall be a minimum of 110 gal/min/sq.ft.
- B. Drainage filter fabric shall meet the following Minimum Average Roll Value (MARV) specifications across the weave:

PROPERTY	TEST METHOD	REQUIREMENT	PROPERTY	TEST METHOD	REQUIREMENT
Grab Tensile Strength	ASTM D-4632	80 lb. min.	Puncture Strength	ASTM D-4833	45 lb. min.

Grab Tensile Elongation	ASTM D-4632	50% max.	UV Resistance	ASTM D-4335	70% at 500 hrs min.
Trapezoidal Tear Strength	ASTM D-4533	35 lb. min.	Apparent opening	ASTM-D-4751	40-80 US Sieve
Mullen Burst Strength	ASTM D-3786	160 psi. min.	Permeability	ASTM D-4491	110 gal/min/ft.2 min.

## PART 3 – EXECUTION

### 3.1 COORDINATION

- A. *Pre-Installation Examination Required:* The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the Owner in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means the Contractor accepts substrates, previous work, and conditions.
- B. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

### 3.2 EXCAVATION AND SCARIFICATION

- A. Excavation of the soils shall be accomplished to a depths noted on the drawings.
  - 1. *Excavation Depths:*
    - a. The 12" x 12" underdrainage trench shall be below the designed soil profiles. Soil profile depth plus 12 inches.
  - 2. *Pipe Trench pitch:* The trench shall be pitched toward the outfall with an average around 1 percent or about 1.25 inches fall per 10 feet where practical.
  - 3. *Subgrade pitch:* The subgrade shall be pitched toward the underdrainage with an average around 0.5-1.0 percent or about 1 inches fall per 10 feet where practical.
- B. Scarification of the Subgrade: After the specified engineering compaction for the subgrade is accomplished, scarification must loosen the compacted surface of the subgrade following final rough grade to a depth of 3 to 4 inches prior to the designed soil placement.

### 3.3 UNDERDRAINAGE PIPING INSTALLATION

- A. Landscape Underdrainage:
  - 1. Place the perforated pipe with perforations at 4 and 8 o'clock (down) with a minimum gradient of 1 percent is applied on a bed of 4 inches of approved washed crushed pea stone.
  - 2. Cleanouts using the end caps shall be placed at the upslope portion of the pipe to allow future flushing of the underdrainage system. Two 45 degree elbow fittings shall be used to equal a 90 degree turn to facilitate smooth flushing and snaking. Then gravel shall encase the pipe at least for 4 inches.

3. Excess filter fabric shall be placed over the underdrainage construction prior to S3 placement to protect the gravel from siltation from other construction activities. The filter fabric shall be removed just prior to S3 placement.
4. ALTERNATE: If flexible perforated pipe is used use the following procedures to ensure fines from entering the piping through perforations at the top:
  - a. If no filter sock is used, cover the top of the pipe with excess filter fabric to provide a tent over the top pipe perforations.
  - b. If filter socks are used, slit the sock on the bottom of the pipe in a length of 6 feet with 1 foot holding fabric, then slit another 6 feet.
  - c. Then cover pipe with Landscape Underdrainage Aggregate.

### 3.4 PROTECTION AND REPAIRS

#### A. General:

1. Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials.
2. Maintain filter fabric covering the underdrainage gravel until the designed soil (S3 layer) is placed.
3. Where settling, sedimentation, or damage occurs to the underdrainage system, inspect and correct prior to placing the designed soil layers.

END OF SECTION 32 91 50

## SECTION 32 92 00 - TURF AND GRASSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Sodding.

- B. Related Requirements:

- 1. Section 32 91 15 "Soil Preparation (Performance Specification) for planting soils.
  - 2. Section 32 93 00 "Plants" for trees, shrubs, ground covers, post construction two-year watering program, and other plants as well as border edgings and mow strips.

#### 1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 15 "Soil Preparation (Performance Specification)" and drawing designations for planting soils.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.5 ACTION SUBMITTALS

### A. Product Data: For the following:

1. Turf.
2. Pesticides.

## 1.6 INFORMATIONAL SUBMITTALS

- ### A. Qualification Data: For landscape Installer.
- ### B. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

## 1.7 CLOSEOUT SUBMITTALS

- ### A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

## 1.8 QUALITY ASSURANCE

- ### A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  2. Experience: Five years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
  3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
    - a. Landscape Industry Certified Technician - Exterior.
    - b. Landscape Industry Certified Lawncare Manager.
    - c. Landscape Industry Certified Lawncare Technician.
  5. Pesticide Applicator: State licensed, commercial.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- ### A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Accompany each delivery of bulk materials with appropriate certificates.

1.10 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
1. May 15 to October 1.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

- A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
1. TifTuf Bermudagrass, (*Cynodon dactylon* (L.) Pers. x *Cynodon transvaalensis* Burt Davy.

2.2 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

### 3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect grade stakes set by others until directed to remove them.

### 3.3 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and install planting soil according to Section 32 91 15 "Soil Preparation (Performance Specification)."
- B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 SODDING

- A. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Architect prior to delivery time. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across slopes exceeding 1:3.
  - 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

### 3.5 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Mow to a height of 1-1/2 to 2 inches.



- D. Turf Postfertilization: Apply type of fertilizer at rate recommended in Soil Analysis after initial mowing and when grass is dry.

### 3.6 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
  - 1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

### 3.7 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

### 3.8 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

### 3.9 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Sodded Turf: 60 days from date of Substantial Completion.

END OF SECTION 32 92 00

## SECTION 32 93 00 - PLANTS

### 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. Plants.
2. Tree stabilization.
3. Landscape edgings.
4. Tree-watering devices.
5. Erosion-control materials
6. ***Post installation watering program***

#### ***Revision 1 GMP3***

- B. Related Sections:

1. Section 01 56 39 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 03 30 01 "Site Cast-in-Place Concrete" for concrete support for tree grate and frame.
3. Section 32 91 15 "Soil Preparation (Performance Specification)" for planting soils and installation.
4. Section 32 92 00 "Turf and Grasses" for turf (lawn) planting.

#### 1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when

removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

- D. Finish Grade: Elevation of finished surface of planting soil.
- E. Moist Soil: The condition of the soil when it maintains its shape when formed into a ball. Deformation of the soil is difficult under hand pressure. Free water is not visible. The condition also is considered the point between the wilting point and field capacity of the soil.
- F. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- G. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- H. Planting Area: Areas to be planted.
- I. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- J. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- K. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- L. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- M. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- N. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- O. 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.
- P. Wet Soil: The condition of the soil at which point it maintains its shape when formed into a ball but easily deforms under hand pressure. Free water is visible within the pore spaces. The water content in this soil condition is considered at field capacity or wetter.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
  - 2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.
  - 3. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- B. Samples for Verification: For each of the following:
  - 1. Organic Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
  - 2. Proprietary Root-Ball-Stabilization Device: One unit.
  - 3. Slow-Release, Tree-Watering Device: One unit of each size required.
- C. Certification of Root Pruning: From grower for trees and tree-like shrubs, stating the plants have been root pruned at each step in the plant production process to remove stem-girdling roots and kinked roots, or the previous liner production system used other practices that produce a root system throughout the root ball that complies with these specifications, and the plants are reasonably free of root defects as described in these specifications.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis of standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.
- D. Warranty: Sample of special warranty.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
  - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  - 2. Experience: Five years' experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements."
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
    - a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
    - b. Certified Ornamental Landscape Professional, designated COLP.
  - 5. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
  - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
  - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Architect will observe plant root systems, and select plant material at place of growth for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
  - 1. Root System Observation: Architect may make invasive observation of the root ball as needed to verify the plant root system complies with the requirements for root condition. Observation of trees grown in containers may require random cutting into the interior root ball of a maximum of 2 percent, but no fewer than two trees of each type of tree in a container at each nursery source. Such cutting and observation may render the plant unsuitable for planting. Findings of these observations will be considered as representative of plants of that type and source.
  - 2. Arrange with Architect a time for selecting plant materials in nurseries.
  - 3. For distant plants that cannot be selected by Architect, submit photographs for pre-observation review.

- 4. Architect will attach seals to selected plants as a means of establishing the quality standard for the plant species and size to be provided.
- E. Substitutions: Substitutions will only be considered after review of availability with Architect. If a plant is not obtainable, consideration will be given to nearest available size or similar species or variety.
- F. Stake-out Observation: Architect will review Installer's stake-out of individual trees and shrubs, and outlines of areas of multiple plantings. Architect retains the right to adjust final locations.
- G. Preinstallation Conference: Conduct conference at Project site.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  - 2. Do not remove container-grown stock from containers before time of planting.
  - 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.
  - 4. If planting occurs in summer, arrange for nursery to dig plants in late spring and place in storage. Protect from weather and mechanical damage. Cover root ball with soil or mulch, and water to keep roots moist. Untie crown bindings to allow branches to return to

natural shape. Space plants far enough apart to avoid touching. Rewrap root ball before moving.

## 1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of each service or utility.
  - 2. Do not proceed with interruption of services or utilities without Owner's written permission.
- C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
  - 1. March 1 to May 15.
  - 2. September 15 to December 15.
    - a. B&B Digging Restrictions: November 1 to April 15.
- D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

## 1.9 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
  - 1. Failures include, but are not limited to, the following:

- a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
  - b. Structural failures including plantings falling or blowing over.
  - c. Faulty performance of tree stabilization and tree grates.
2. Warranty Periods from Date of Substantial Completion: ~~12~~ **24** months.

***Revision 1 GMP-3***

3. Include the following remedial actions as a minimum:
  - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
  - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
  - c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
  - d. Provide extended warranty for period equal to original warranty period, for replaced plant material. If replacement is not accepted at end of warranty period, the Architect may elect subsequent replacement or credit for item.

1.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrub and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
  1. Maintenance Period: ~~12~~ **24** months from date of Substantial Completion.

***Revision 1 GMP-3***

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.



1. Grade: "Quality Grade;" well-shaped, fully and evenly branched and densely foliated when in leaf, unless indicated otherwise on Plant Schedule.
  2. Trees with 3-Inch Caliper and Greater: Provide crown with diameter equal to minimum 40 percent of height.
  3. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
  4. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
  5. Species: Provide straight species unless indicated otherwise on Plant Schedule.
  6. Trees and shrubs grown at latitude not more than 200 miles north or south of latitude of project unless provenance of trees or shrubs can be documented to be compatible with latitude and cold hardiness of project location.
  7. Inspection for Mite and Scale: Inspect trees in March immediately preceding digging for mite eggs and scale.
- B. Root System for Trees and Tree-Like Shrubs: Provide plants having roots complying with the following:
1. A minimum of three structural roots reasonably distributed around the trunk. Plants with structural roots on only one side of the trunk are unacceptable.
  2. The root crown a maximum of two inches below the soil line; the top two structural roots a maximum of three inches below the soil line at a distance of 4 inches from the trunk; and the top of other structural roots a maximum of 5 inches at a distance of 4 inches from the trunk. The grower may request a modification to this requirement for species with roots that rapidly descend, providing the grower removes all circling roots above the structural roots across the top of the structural roots.
  3. The root system reasonably free of root defects including potentially stem-girdling roots above the root collar and main structural roots, vertical roots, and /or kinked roots from nursery production practices, including roots on the interior of the root ball.
- C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
1. Overwinter herbaceous plants.
- D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- E. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.
- F. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

## 2.2 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  - 1. Types:
    - a. Triple shredded hardwood bark.

## 2.3 PESTICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

## 2.4 TREE STABILIZATION MATERIALS

- A. Root-Ball Stabilization Materials:
  - 1. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized according to manufacturer's written recommendations unless otherwise indicated.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide Tree Staple, Inc.; Models TS36 and TS42, or a comparable product.

## 2.5 TREE-WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. BIO-PLEX.
    - b. Engineered Watering Solutions; PQ Partners, LLC.
    - c. Spectrum Products, Inc.

2. Color: As selected by Architect from manufacturer's full range.

## 2.6 EROSION-CONTROL MATERIALS

- A. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended wood stakes, 12 inches long.

## 2.7 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Root-Dip: Soluble inoculant containing live spores of endomycorrhiza and ectomycorrhiza fungi, biostimulants and water-holding gel.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Lebanon Seaboard Corp.; "PHC Terra-Sorb" plus "PHC Root Dip" or comparable products by one of the following:
    - a. BioPlex Organics.
    - b. Bio Organics.
- C. Mycorrhizal Inoculant: Mycorrhizal inoculant containing live spores of endomycorrhiza and ectomycorrhiza fungi for wet or dry application.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Lebanon Seaboard Corp.; "PHC Tree Saver" or a comparable product by one of the following:
    - a. BioPlex Organics.
    - b. Bio Organics.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
  1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  3. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

### 3.3 PLANTING AREA ESTABLISHMENT

- A. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 INSTALLATION OF EROSION-CONTROL MATERIALS

- A. Install erosion-control mesh from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- B. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

### 3.5 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  - 1. Excavate to dimensions indicated on Drawings.
  - 2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
  - 3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  - 4. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  - 5. Maintain supervision of excavations during working hours.
  - 6. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Subsoil removed from excavations shall be used as planting soil as indicated on Drawings.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

### 3.6 TREE, SHRUB, AND VINE PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
  - 1. Use planting soil for backfill. For trees, use a mix of excavated soil and planting soil for backfill in bottom half of pit as indicated on Drawings.
  - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
    - a. For trees planted with root-ball stabilization, leave burlap and twine intact until root-ball stabilization device is installed. After installation, cut back burlap and twine around tree trunk, leaving material under cross bars.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  4. Apply mycorrhizal inoculant into backfill according to manufacturer's written instructions.
  5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
1. Use planting soil Insert drawing designation for backfill.
  2. Carefully remove root ball from container without damaging root ball or plant.
  3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  4. Apply mycorrhizal inoculant into backfill according to manufacturer's written instructions.
  5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. When planting on slopes, set the plant so the root flare on the downhill side is flush with the surrounding soil on the slope; and as indicated on Drawings.

### 3.7 TREE, SHRUB, AND VINE PRUNING

- A. Prune to remove dead, dying, or broken branches and to shape trees, shrubs, and vines as directed by Architect. Do not prune to thin.
- B. Do not apply pruning paint to wounds.

### 3.8 TREE STABILIZATION

- A. Root-Ball Stabilization: Install at-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
  1. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

### 3.9 HERBACEOUS PLANT PLANTING

- A. Set out and space herbaceous plants other than trees, shrubs, and vines as indicated in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.

- D. Dip plant root ball in solution of root dip. Comply with manufacturer's written instructions.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

### 3.10 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
  - 1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 24-inch radius, or as indicated on Drawings, around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
  - 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
  - 3. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of mineral mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

### 3.11 EDGING INSTALLATION

- A. Shovel-Cut Edging: Separate mulched areas from turf areas with a 45-degree, 4- to 6-inch-deep, shovel-cut edge as shown on Drawings.

### 3.12 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

### 3.13 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### 3.14 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

### 3.15 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
  - 1. Do not remove Architect's seals from trees.
- D. At end of maintenance period, remove Architect's seals, and built-up earth saucers around plants. Redistribute mulch.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

### 3.16 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.



### **3.17 POST INSTALLATION WATERING PROGRAM**

- A. The Contractor is to provide a two-year watering program to ensure all plantings are established.**
- B. If no water source is available from the Phase 1 project boundaries; the project building, from within the project limits such as a hose bib, or a nearby source approved by the Owner then the Contractor will be required to provide water from an outside source and deliver it to the project.**
- C. If water is to be provided by the Contractor from an outside source the Contractor shall submit a report outlining the source, the quality of the water and all supplemental treatments added to the water for review and approval.**
- D. The Contractor is to submit to the Architect a proposed watering schedule for review and approval two months before the start of plant installations.**
- E. The Contractor will be responsible to water all plant materials on a timely basis to ensure healthy growth during the two-year period and submit to the Architect a monthly report defining the dates of watering and an evaluation of the plant conditions observed.**
- F. All other planting requirements as outlined in this Specification are to be followed during the two-year period.**

*Revision 1 GMP-3*

END OF SECTION 32 93 00

## SECTION 32 94 50 – WELDED WIRE PANEL PLANT SUPPORT SYSTEM

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.02 SUMMARY

- A. Section Includes:
  - 1. Welded wire grid panels.
  - 2. Panel channel and angle trim.
  - 3. Panel posts.
  - 4. Necessary clips, straps and spacers.
  - 5. Powdercoat finish
- B. Related Sections:
  - 1. Section 31 20 00 "Earth Moving" for site excavation, fill, and backfill where decorative metal fences and gates are located.
  - 2. Section 03 30 00 "Cast-in-Place Concrete" for concrete.
  - 3. Section 32 93 00, "Plants" for furnishing and installing related plants.

#### 1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories and hardware.
- C. Samples: For each fence material and for each color specified.
  - 1. Provide Samples 12 inches in length for linear materials.
  - 2. Provide Samples 12 inches square for wire mesh.

#### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Manufacturer: Minimum 10 years experience in manufacturing and supplying welded wire panel systems of the type required for this Project.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Include one section of fence system (two posts with footing and one panel system) complying with requirements.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 3 Section "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

### 2.02 ACCEPTABLE MANUFACTURERS

- A. Greenscreen, 725 S. Figueroa St. Suite 1825, Los Angeles, CA 90017; Tel: 1-800-450-3494; [sales@greenscreen.com](mailto:sales@greenscreen.com), [www.greenscreen.com](http://www.greenscreen.com).
- B. Omega II Fence Systems, 1735 St.-Elzear Blvd. West, Laval, Quebec Canada, H7L 3N6; Tel: 1-800-836-6342; [customerservice@omegatwo.com](mailto:customerservice@omegatwo.com).
- C. Custom fabricated application.

### 2.03 PANELS

- A. Panels shall be rigid, three-dimensional welded wire grid fabricated of 14 gauge galvanized steel wire.
  1. Metallic-Coated Steel Wire: Welded-wire, galvanized in accordance with ASTM A641.
- B. Face Grid: Wires shall be welded at each intersection to form a 2 x 2 inch face grid on the front and back of panels.
- C. Trusses: Face grids shall be separated by bent wire trusses spaced at 2-inch centers and welded to front and back face grids at each truss apex.
- D. Thickness: 3 inches.
- E. Length and Width: As indicated on the Drawings.
- F. Tolerance: 1/8 inch in width and 1/8 inch in length.

### 2.04 ACCESSORIES

- A. Trim:
  1. Fabricate from 20-gauge ASTM A879 galvanized steel.
  2. Types:
    - a. Channel Trim: Thickness of panel x ½ inch legs.
    - b. Angle Trim: ½ inch x ½ inch legs.
  3. Locations:
    - a. As indicated on the Drawings.

- B. Clips and Straps: Provide manufacturer's standard types of clips and straps suitable for mounting conditions. Fabricate from ASTM A879 galvanized steel. Adjustable clips shall have ¼ inch diameter 18-8 stainless steel bolt, washer, and nut.
- C. Plastic Spacers: Provide ½ inch thick black Ultra High Molecular Weight polyethylene (UHMW) washers [to hold clips away from mounting surface].
- D. Fence Posts: 3-inch 2-7/8" OD ASTM A500 steel tube. The steel strip used in the manufacture of the post shall conform to ASTM A1011. Minimum yield strength shall be 45,000 psi. Provide steel post caps. Overall post length shall be as indicated on the Drawings.
- E. Fasteners for Mounting Clips to Fence Posts: Self drilling, self tapping hex washer head screws, with strength of Type 410 stainless steel, and corrosion resistance of Type 304 stainless steel.

## 2.05 METALLIC-COATED STEEL FINISHES

- A. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a zinc-phosphate conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
- B. Powder Coating: Immediately after cleaning and pretreating, apply manufacturer's standard finish. Comply with coating manufacturer's written instructions.
  - 1. Color and Gloss: Black, manufacturer's standard textured.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Stake locations of fence lines and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
  - 1. Construction layout and field engineering are specified in Division 1 Section "Execution Requirements."

### 3.03 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions. If product is to be custom fabricated provide to the Architect installation process anticipated.

- B. Install fences by setting posts as indicated and fastening to posts. Peen threads of bolts after assembly to prevent removal.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to dimensions indicated on Drawings.
- D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - a. Concealed Concrete: Top 2 inches below grade as indicated on Drawings to allow covering with surface material. Slope top surface of concrete to drain water away from post.
  - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
  - 4. Space posts uniformly at o.c. spacing indicated on Drawings.

END OF SECTION 32 94 50

## SECTION 33 11 00 - WATER UTILITIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes water-distribution piping and related appurtenances from tapping of main to:
  - 1. Within 5 feet of outside the building limits for domestic and irrigation water service; and,
  - 2. 1 foot above finished floor elevation for fire service mains.
  - 3. Supply and discharge piping, including connections, to fire protection water tank if shown on plans.
- B. All work shall conform to the requirements of the local water authority, fire marshal, any other regulatory authorities having jurisdiction, or this specification, whichever is more stringent.
- C. Contractor to provide as-built PDF and CAD file including all sanitary sewer data by a licensed surveyor. Reference Survey and Layout specification section for information on necessary as-built to be provided by the Contractor.
- D. Do not put into operation until all testing and approvals have been received.

#### 1.2 REFERENCED SECTIONS

- A. Section 31 23 17 – Trenching and Excavation

#### 1.3 REFERENCE STANDARDS

- A. Factory Mutual (FM)
  - 1. Approval Guide
- B. Underwriters Laboratories (UL)
  - 1. Fire Protection Equipment Directory
  - 2. UL 1285 - Pipe and Couplings, Polyvinyl Chloride (PVC), for Underground Fire Service
  - 3. UL 262 - Gate Valves for Fire-Protection Service
  - 4. UL 246 - Hydrants for Fire-Protection Service
- C. National Sanitation Foundation (NSF)
  - 1. NSF 14 - Plastics Piping System Components and Related Materials
  - 2. NSF 61 - Drinking Water System Components - Health Effects
- D. National Fire Protection Association (NFPA)
  - 1. NFPA 70 - National Electrical Code
  - 2. NFPA 24 - Standard for the Installation of Private Fire Service Mains and their Appurtenances
  - 3. NFPA 1963 - Screw Threads and Gaskets for Fire Hose Connections (revision of ANSI/NFPA 1963-1993)
  - 4. NFPA 13 – Installation of Sprinkler Systems (latest edition)
- E. American Water Works Association (AWWA)
  - 1. C151 Ductile-Iron Pipe, Centrifugally Cast, for Water (revision of ANSI/AWWA C151/A21.51-91)
  - 2. C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
  - 3. C150 - Thickness Design of Ductile-Iron Pipe
  - 4. C110 - Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (75 mm through 1200 mm), for Water and Other Liquids
  - 5. C153 - Ductile-Iron Compact Fittings, 3 in. through 24 in. (76 mm Through 610 mm) and 54 in. through 64 in. (1,400 mm Through 1,600 mm), for Water Service
  - 6. C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inch through 12 Inch for Water Distribution
  - 7. C500 - Gate Valves for Water and Sewage Systems
  - 8. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

9. C550 - Protective Epoxy Interior Coatings for Valves and Hydrants
  10. C509 - Resilient-Seated Gate Valves for Water Supply Service
  11. M44 – Distribution Valves: Selection, Installation, Field Testing, and Maintenance
  12. C800 - Underground Service Line Valves and Fittings
  13. C702 - Cold Water Meters - Compound Type
  14. C502 - Hydrants, Dry Barrel Fire
  15. M41 – Ductile Iron Pipe and Fittings
  16. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances
  17. C605 - Water Treatment - Underground Installation of Polyvinyl Chloride PVC Pressure Pipe and Fittings for Water
  18. M23 - PVC Pipe: Design and Installation
  19. M17 - Fire Hydrants: Installation, Field Testing, and Maintenance
  20. C651 - Disinfecting Water Mains
  - F. American Society for Testing and Materials (ASTM)
    1. B88 - Standard Specification for Seamless Copper Water Tube
    2. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
    3. B32 - Standard Specification for Solder Metal
    4. D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
    5. D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
    6. F645 - Standard Guide for Selection, Design, and Installation of Thermoplastic Water Pressure Piping Systems
  - G. American Society of Mechanical Engineers (ASME)
    1. B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings R(1994)
    2. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  - H. Manufacturer's Standardization Society (MSS)
    1. SP-60 - Connecting Flange Joint Between Tapping Sleeves and Tapping Valves
  - I. Copper Development Association (CDA)
    1. Copper Tube Handbook
- 1.4 QUALITY ASSURANCE
- A. Regulatory Requirements: Comply with requirements of the regulatory authorities having jurisdiction; including tapping of water mains, backflow prevention, installation, testing, and disinfection. Comply with standards of the regulatory authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
  - B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
  - C. Electrical Components, Devices, and Accessories: UL listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the regulatory authorities having jurisdiction, and marked for intended use.
  - D. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
  - E. NFPA Compliance: Comply with NFPA 13 and NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
  - F. NSF Compliance: Comply with NSF 14 for plastic potable-water-service piping. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.
  - G. Comply with requirements of Section 31 2317 - Trenching and Excavation.
- 1.5 SUBMITTALS

- A. The General Contractor and the Subcontractor shall execute the Conformance Submittal(s) at the end of this section.

#### 1.6 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 the Owner not less than 2 days in advance of proposed utility interruptions; and,
  - 2. Do not proceed with utility interruptions without written permission from the Owner.
- B. Removal/Relocation of Existing Utilities: The contractor shall be responsible for removal and/or relocation of existing utilities, whether shown or not shown on the drawings, at locations where conflicts occur with proposed water line improvements at no additional cost to the owner.

#### 1.7 COORDINATION AND FEES

- A. All new construction and any renovation that establishes labeling conventions for nonelectric utilities shall follow the standards set forth in the most recent version of ANSI/ASME 13.1.
- B. Labels shall indicate the type of utility and direction of flow on all labels. Labels shall also be no more than 20 feet apart. For dual temperature hydronic piping, the standard convention of green with white writing shall be used with labeling as Dual Temp. Supply (DTS) and Dual Temp. Return. (DTR).
- C. When an existing convention other than the one listed above is present, the existing color-coding system shall be followed for all new work on the system while maintaining the label spacing and direction of flow indication above.
- D. Specify that no domestic water piping is installed as to enter a building from under the finished concrete slab.
- E. Design must allow for and specify that piping shall be buried below recorded frost penetration, but no less than 36" below finished grade.
- F. Specify the installation of appropriate thrust blocks that are needed to properly anchor piping at changes in direction and other required locations. The design must clearly indicate the details required for these thrust blocks.
- G. Clearly specify the coordination of any permitting requirements for the installation of these water lines – both the permit to construct and the permit to operate the system. See Division 00 for permitting responsibilities. Specify the level and the method of disinfection of these water lines in accordance with permit requirements or other code requirements.
- H. Regulations contained in the Safe Drinking Water Act concerning lead and copper concentrations shall be complied with, including the specification and the selection of piping materials to ensure this compliance.
- I. The Contractor shall be responsible for obtaining and payment of all tap and construction permit fees associated with this section.
- J. The Contractor shall provide and install domestic and irrigation water lines, meters, and appurtenances as shown on the drawings to within 5 feet of building limits, including, but not limited to, any taps, meters, vault, and backflow prevention. If Contractor's work terminates at a connection point where work by others is complete, Contractor shall make the connection. If future connections will be required by others, Contractor shall install plugging and marking apparatus as necessary to protect his work.
- K. The Contractor shall provide and install fire service water lines, meters, and appurtenances as shown on drawings to 1 foot above finished floor elevation, including, but not limited to any taps, meters, backflow prevention, hydrants, and free standing fire department connections. If Contractor's work terminates at a connection point where work by others is complete, Contractor



shall make the connection. If future connections will be required by others, Contractor shall install plugging and marking apparatus as necessary to protect his work.

## PART 2 - MATERIALS AND APPLICATION

### 2.1 PIPE AND FITTINGS, APPLICATION

Ductile Iron Pipe (DIP), all sizes:

1. All DIP pipe shall be in accordance with AWWA C600 and AWWA M41. Fittings shall be mechanical-joint ductile-iron compact fittings in accordance with AWWA C153 or standard size in accordance with AWWA C110.

### 2.2 VALVES

#### A. Cast-Iron, Gate Valves:

1. All gate valves to be manual.
- B. Specify that all underground valves shall be provided with a valve box and cover to allow access.
- C. Valves installed in unpaved areas shall have concrete “donut” rings around the valve cover at the ground surface for protection.
- D. Installations requiring special operating tools shall have the applicable tool furnished with the installation.

### 2.3 POST INDICATOR VALVES

- #### A. Post indicator valves shall be UL listed and FM approved.

### 2.4 FITTINGS

- #### A. Mechanical joint Tyler Union Fittings and EBAA Iron Restraint Joint System to be used.

### 2.5 WATER METERS

- A. 2 inch Service Meters: AWWA C702, compound-type, bronze main case. Register flow in gallons.
- B. Fire Service Meters: AWWA C703, bronze case. Register flow in gallons. Use fire service meters only when required by the regulatory authorities having jurisdiction code.
- C. Water Meter Boxes: Cast-iron body and cover (H2O rated) with lettering "WATER METER" in cover; and slotted, open-bottom base section of length to fit over service piping. Use only when required by the utility authority. Provide a 2' x 2' x 6" concrete apron around all valve boxes in asphalt pavement areas.

### 2.6 BACKFLOW-PREVENTION DEVICES

- #### A. Comply with regulatory authorities having jurisdiction requirements. Maximum pressure loss for a double detector check valve shall be 5 psi @ 2250 gpm and maximum pressure loss for a RPZ shall be 12 psi @ 2250 gpm.

### 2.7 FREESTANDING FIRE HYDRANTS

- #### A. Dry-Barrel Fire Hydrants: AWWA C502, UL 246, FM-approved, 1 NPS 4.5 inch and 2 NPS 2.5 inch outlets, 5.25 inch main valve, drain valve, and NPS 6 inches mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure, and 150-psig minimum working-pressure design. Provide a 2' x 2' x 6" concrete apron around all hydrant valves in asphalt pavement areas.
1. Mueller Super Centurion 250 Fire Hydrant A421 to be used.
  2. Outlet Threads: NFPA 1963, with external hose thread used by regulatory authorities having jurisdiction, including fire department. Include cast-iron caps with steel chains;

3. Operating and Cap Nuts: Pentagon, standard;
  4. Direction of Opening: standard, a clearly visible arrow and the word “open” shall be cast in relief on the top of the hydrant so as to designate the direction of opening; and,
  5. Exterior Finish: Red alkyd-gloss enamel paint, two coats.
- 2.8 RESTRAINED JOINT SYSTEMS FOR FIRE LINE LEAD-IN
- A. The following section shall only apply to the portion of fire protection main extending from the 90 degree elbow below the sprinkler riser room floor to the flanged end of the pipe extending 1'-0" above the sprinkler riser room finished floor and the horizontal portion of pipe extending from the 90 degree elbow towards the building foundation.
  - B. The fire protection main entering the sprinkler riser room through the floor shall be restrained from movement by the following:
    1. Pipe Clamps
      - a. Clamp dimensions shall be 5/8" x 2 1/2" for 10" pipe, 5/8" x 3" for 12" and larger pipe;
      - b. Clamp bolt dimensions shall be 3/4" for 10" pipe, 7/8" for 12" and larger pipe;
      - c. The diameter of the bolt hole shall be 1/16" larger than that of the corresponding bolt.
    2. Tie Rods: Threaded sections of rods shall not be formed or bent. Rods shall not be less than 5/8" in diameter and the minimum number of rods for each clamp shall be:
      - a. 10" Pipe: (4)-5/8" or (3)-3/4" or (2)-7/8" rods;
      - b. 12" Pipe: (6)-5/8" or (4)-3/4" or (3)-7/8" rods; and
      - c. 14" Pipe: (8)-5/8" or (5)-3/4" or (4)-7/8" rods
      - d. 16" Pipe: (10)-5/8" or (7)-3/4" or (5)-7/8" rods
    3. Washers
      - a. Cast-iron washer dimensions shall be 5/8" x 3" for 10" pipe, 1/2" x 3 1/2" for 12" pipe and larger;
      - b. Steel washer dimensions shall be 1/2" x 3" for 10" pipe, 1/2" x 3 1/2" for 12" pipe and larger; and
      - c. The diameter of the hole in the washer shall be 1/8" larger than the rod.
    4. Polyethylene Encasement: To prevent corrosion, a polyethylene tube/sheet shall be applied to the exterior piping, fittings, clamp and rods. The polyethylene casing shall be applied per the manufacturer's listing and shall extend 6" above finished floor elevation in the sprinkler room.

### PART 3 - EXECUTION

- 3.1 TRENCHING
- A. Comply with requirements of Section 31 2317, Trenching and Excavation.
- 3.2 VALVES
- A. General Application: Use mechanical joint valves for NPS 2 inch and larger underground installation. Use threaded or flanged-end valves for installation in vaults.
  - B. Provide 2' x 2' x 6" concrete apron around all valve boxes in asphalt pavement areas.
- 3.3 PIPE AND FITTING INSTALLATION
- A. Water-Main Connection: Verify with regulatory authorities having jurisdiction that size of tap and location shown on drawings is acceptable. Make tap conforming to requirements of regulatory authorities having jurisdiction and Manufacturers Standardization Society (MSS) standards.
  - B. Comply with NFPA 24 for fire-service-main piping materials and installation.
  - C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
  - D. Install copper tube and fittings in accordance with Copper Development Association (CDA) "Copper Tube Handbook."

- E. Install any combined domestic and fireline pipe per NFPA 24.
- F. All piping shall be installed with a minimum of 42 inches of cover, or 12 inches below level of max frost penetration, or as required by regulatory authorities having jurisdiction, whichever is deeper. If pipe is installed in a cut section prior to completion of grading operations, pipe shall be installed so that minimum required cover will exist upon completion of grading operations.
- G. Terminate water piping as required per above Article 1.06.
- H. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports. See thrust block details on drawings.
- I. Pipe Bedding: Pipe bedding material shall be installed if required by regulatory authorities having jurisdiction if shown on drawings. No pipe shall be laid resting on a rock, blocking or unyielding objects.
- J. Location with Sewers: Separate trenches shall be provided for water lines and sewer lines, with lines separated by a minimum of 10 feet horizontally. Water mains that cross sewers shall have a minimum vertical separation of 18 inches.
- K. All piping shall be installed and verified to be level. This shall apply to piping in the horizontal and vertical positions.

### 3.4 ANCHORAGE INSTALLATION

- A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600;
  - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23;
  - 3. Fire-Service-Main Piping: According to NFPA 24; and,
  - 4. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.5 BACKFLOW-PREVENTER INSTALLATION

- A. Comply with regulatory authorities having jurisdiction, including water authority requirements.
- B. Do not install bypass piping around backflow preventers.

### 3.6 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Comply with AWWA M17 and NFPA 24.

### 3.7 QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water. **Do not put line into operation until all testing has been completed and approved by Civil Engineer and Clemson University and SCDHEC Permit to Operate is obtained in the case of Permit to Construct was obtained. Do not demo existing lines until new lines are in operation.**
- B. Hydrostatic Tests:
  - 1. The Contractor shall test all pipe lines and appurtenances with water at test pressure of 200 psi or 50 psi in excess of the system working pressure, whichever is greater. Test pressure must be maintained for at least 2 hours. All leakage apparent after testing must be repaired immediately. The work will not be finally accepted until leakage shall be as follows:
    - a. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, irrespective of pipe diameter.

- b. The amount of leakage specified above shall be permitted to be increased by 1 fluid ounce per inch valve diameter per hour for each metal seated valve isolating the test section.
  - c. If dry barrel hydrants are tested with the main valve open so the hydrants are under pressure, an additional 5 fluid ounces per minute shall be permitted for each hydrant.
  - d. The amount of leakage in buried piping shall be measured at the specified test pressure by pumping from a calibrated container.
- 2. Fire Water System tests shall be in full conformity with the requirements of all applicable codes, NFPA standards, IFC, 2018 edition and other authorities having jurisdiction.
  - a. All new underground mains and lead-ins shall be flushed thoroughly before connection is made to internal system piping. The site utility subcontractor shall be responsible for disposal of the test water drained from the test outlets.
  - b. The trench shall be backfilled between joints before testing to prevent movement of pipe.
  - c. Test shall be made by the site utility subcontractor in the presence of the regulatory authority having jurisdiction and/or the Owner's representative.
  - d. After the fire service underground main and lead-in have been installed by the site utility subcontractor and are ready for use, the site utility subcontractor shall furnish 2 completed copies of the "Contractor's Material and Test Certificate for Private Fire Service Mains" form to the General Contractor. Prior to attachment of any pipe or equipment to the lead-in located in the sprinkler room, the sprinkler subcontractor shall obtain a copy of the completed form from the General Contractor.
  - e. The site utility subcontractor shall prepare reports of testing activities and submit 2 copies to the General Contractor.

### 3.8 IDENTIFICATION

- A. Install continuous underground detectable warning tape in accordance with Section 31 2000 – Earth Moving, or a 14-gauge solid copper tracer wire prior to backfilling of trench for underground PVC water-service piping. Locate below finished grade, directly over piping.

### 3.9 CLEANING AND FLUSHING

- A. Clean and disinfect water-distribution piping as follows:
  - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use;
  - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet;
  - 3. Use purging and disinfecting procedure prescribed by regulatory authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below; and,
    - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
    - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination
  - 4. The site utility subcontractor shall prepare reports of purging and disinfecting activities and submit 2 copies to the General Contractor.
  - 5. All fire protection underground mains shall be flushed per the flow rates listed below:

Fire Pump and/or Water Storage Tank Installed		No Fire Pump or Water Storage Tank	
8" pipe	2,350 gpm	8" pipe	1,560 gpm
10" pipe	3,670 gpm	10" pipe	2,440 gpm
12" pipe	5,290 gpm	12" pipe	3,520 gpm
14" pipe	7,188 gpm		
16" pipe	9,388 gpm		

Underground and lead-in fire protection mains shall be flushed through fire hydrants at dead ends of the underground piping system or through aboveground flushing outlets which are accessible, will allow water to drain to a safe location and will provide the required flow listed above. Flush underground mains until water is clear. Continue to flush for five minutes after water is clear. Utilize approved waterflow measuring devices to verify that the required waterflow is achieved.

**END OF SECTION 33 11 00**

**APPROVED SCDHEC SPECS TO FOLLOW**

**CONFORMANCE SUBMITTAL**

**SECTION 33 11 00 – WATER DISTRIBUTION**

Project \_\_\_\_\_

General Contractor: \_\_\_\_\_  
(Company Name, Phone Number)

\_\_\_\_\_  
(Address)

Sub-Contractor: \_\_\_\_\_  
(Company Name, Phone Number)

\_\_\_\_\_  
(Address)

---

The following products have been selected (check one box) for use in this project from the list of acceptable products specified:

Domestic and Fire Mains:

- ☐ Ductile-Iron Pipe, AWWA C151 Class 350, MJ DI Compact Fittings
- ☐ Polyvinyl Chloride (PVC) Pipe, AWWA C900, Class \_\_\_\_\_, MJ DI Compact Fittings
- ☐ Other per AHJ: \_\_\_\_\_

Domestic and Irrigation Supply Lines:

- ☐ Copper Tubing, ASTM B88, Type K, Annealed Temper, Copper Fittings
- ☐ Polyvinyl Chloride (PVC) Pipe, ASTM D2241, SDR 21
- ☐ Other per AHJ: \_\_\_\_\_

Fire Hydrants, BFP's, Valves, Meters, Fittings, Vaults, and all other Appurtenances:

- ☐ Conform to Project Specifications and All Authorities Having Jurisdiction

I represent to Owner that the product selected will be installed in compliance with the applicable codes for the authorities having jurisdiction and in accordance with the contract documents. If noncompliance is discovered the General Contractor shall make or cause to be made all necessary corrections to meet the applicable codes and specifications. Immediately or as directed by owner the work shall be completed without additional cost to the owner and / or the contract.

Sub-Contractor:

\_\_\_\_\_  
*(Signature of the Authorized Agent of the Sub-Contractor)*

Date

\_\_\_\_\_  
*(Print Name of the Authorized Agent of the Sub-Contractor)*

General Contractor:

\_\_\_\_\_  
*(Signature of the Authorized Agent of the General Contractor)*

Date

\_\_\_\_\_  
*(Print Name of the Authorized Agent of the General Contractor)*

WATER DISTRIBUTION SYSTEM CERTIFICATION FORM

<b>Project</b>	
<b>Date</b>	
<b>Engineer</b>	
<b>General Contractor</b>	
<b>Utility Contractor</b>	
<b>Const. Mgr.</b>	

**ENGINEER CERTIFICATION (If required)**

I certify that the water distribution system for the above referenced project has been installed and tested in accordance with local code and Owner's Plans and Specifications dated \_\_\_\_\_.

Engineer \_\_\_\_\_

Registration No. \_\_\_\_\_

Affix Seal Here (not valid unless sealed)

Date \_\_\_\_\_

**GENERAL CONTRACTOR CERTIFICATION (Required)**

I certify that the water distribution system for the above referenced project has been installed and tested in accordance with local code and Owner's Plans and Specifications dated \_\_\_\_\_.

General Contractor \_\_\_\_\_

License No. \_\_\_\_\_

Date \_\_\_\_\_

**UTILITY CONTRACTOR CERTIFICATION (Required)**

I certify that the water distribution system for the above referenced project has been installed and tested in accordance with local code and Owner's Plans and Specifications dated \_\_\_\_\_.

Utility Contractor \_\_\_\_\_

License No. \_\_\_\_\_

Date \_\_\_\_\_

\* Submit this certification form with test results, local certificates, etc.



# FIRE MAIN CERTIFICATION FORM

Contractor's Material and Test Certificate for Underground Piping	
<b>PROCEDURE</b> Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job. A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.	
Property name _____ Date _____	
Property address _____	
Plans	Accepted by approving authorities (names) _____
	Address _____
	Installation conforms to accepted plans <input type="checkbox"/> Yes <input type="checkbox"/> No Equipment used is approved <input type="checkbox"/> Yes <input type="checkbox"/> No If no, state deviations _____
	Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? <input type="checkbox"/> Yes <input type="checkbox"/> No If no, explain _____
Instructions	Have copies of appropriate instructions and care and maintenance charts been left on premises? <input type="checkbox"/> Yes <input type="checkbox"/> No If no, explain _____
	Location _____ Supplies buildings _____
Underground pipes and joints	Pipe types and class _____ Type joint _____
	Pipe conforms to _____ standard <input type="checkbox"/> Yes <input type="checkbox"/> No Fittings conforms to _____ standard <input type="checkbox"/> Yes <input type="checkbox"/> No If no, explain _____
	Joints needed anchorage clamped, strapped, or blocked in accordance with _____ standard <input type="checkbox"/> Yes <input type="checkbox"/> No If no, explain _____
	Test description Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 390 gpm (1476 L/min) for 4-in. pipe, 880 gpm (3331 L/min) for 6-in. pipe, 1560 gpm (5905 L/min) for 8-in. pipe, 2440 gpm (9235 L/min) for 10-in. pipe, and 3520 gpm (13,323 L/min) for 12-in. pipe. When supply cannot produce stipulated flow rates, obtain maximum available. Hydrostatic: Hydrostatic tests shall be made at not less than 200 psi (13.8 bar) for 2 hours or 50 psi (3.4 bar) above static pressure in excess of 150 psi (10.3 bar) for 2 hours. Leakage: New pipe laid with rubber gasketed joints shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 quarts per hour (1.89 L/hr) per 100 joints irrespective of pipe diameter. The leakage shall be distributed over all joints. If such leakage occurs at a few joints, the installation shall be considered unsatisfactory and necessary repairs made. The amount of allowable leakage specified above can be increased by 1 fluid ounce per inch valve diameter per hr. (30 mL/25 mm/hr) for each metal seated valve isolating the test section. If dry barrel hydrants are tested with the main valve open so the hydrants are under pressure, an additional 5 ounces per minute (150 mL/min) leakage is permitted for each hydrant.
Flushing tests	New underground piping flushed according to _____ standard by (company) <input type="checkbox"/> Yes <input type="checkbox"/> No If no, explain _____
	How flushing flow was obtained <input type="checkbox"/> Public water <input type="checkbox"/> Tank or reservoir <input type="checkbox"/> Fire pump
	Through what type opening <input type="checkbox"/> Hydrant butt <input type="checkbox"/> Open pipe
	Lead-ins flushed according to _____ standard by (company) <input type="checkbox"/> Yes <input type="checkbox"/> No If no, explain _____
Flushing tests	How flushing flow was obtained <input type="checkbox"/> Public water <input type="checkbox"/> Tank or reservoir <input type="checkbox"/> Fire pump
	Through what type opening <input type="checkbox"/> Y connection to flange and spigot <input type="checkbox"/> Open pipe

Hydrostatic test	All new underground piping hydrostatically tested at _____ psi for _____ hours		Joints covered <input type="checkbox"/> Yes <input type="checkbox"/> No
Leakage test	Total amount of leakage measured _____ gallons _____ hours		
	Allowable leakage _____ gallons _____ hours		
Hydrants	Number installed	Type and make	All operate satisfactorily <input type="checkbox"/> Yes <input type="checkbox"/> No
Control valves	Water control valves left wide open If no, state reason		<input type="checkbox"/> Yes <input type="checkbox"/> No
	Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm		<input type="checkbox"/> Yes <input type="checkbox"/> No
Remarks	Date left in service		
Signatures	Name of installing contractor		
	Tests witnessed by		
	For property owner (signed)	Title	Date
	For installing contractor (signed)	Title	Date
Additional explanation and notes			

## Section 2G2 – Exterior Water Piping

### 1 GENERAL

#### 1.1 Standards

- A. All standards cited in this specification refer to the latest revision of that standard under the same specification number or to superseding specifications under a new number.

#### 1.2 Related Documents

- A. The general provisions of Division 1 shall govern this section.

#### 1.3 Description of Work

- A. This section includes furnishing all labor, materials, and equipment and performance of all operations required for the installation of underground pressure lines, including valves, service connections, and all appurtenances as shown on the drawings and specified herein.
- B. The layout of lines and elevations at governing points are shown on the drawings.
- C. The entire pressure pipe installation will be conducted under the inspection of the engineer and local water utility to simplify communication. The contractor shall be responsible for giving all notices to, coordinating all work with, and complying with all instructions of the engineer. An acceptably completed system will be a system approved for operation by the engineer.
- D. The contractor will work with the owner or the engineer in all matters pertaining to this contract, the work schedule and completion of the work.
- E. The following is a description of the normal work procedure which will be followed on this project:
1. There will be a pre-construction meeting between the contractor, owner, the engineer, and local water utility for coordination purposes.
  2. The contractor shall be responsible for all excavating and backfilling for taps and connections.
  3. Before service taps are made, the distribution system shall be completed, pressure tested and sterilized with acceptable sampling from the system. Service lines will terminate two feet from the right-of-way line with the contractor furnishing curb stops.

SC DEPT. of HEALTH & ENVIRONMENTAL CONTROL

BUREAU OF WATER

STANDARD SPECIFICATIONS APPROVAL

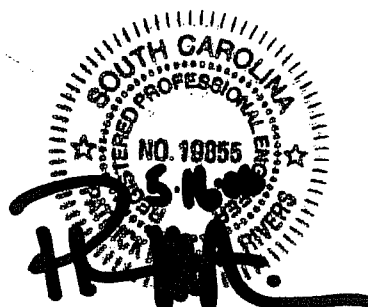
WATER SYSTEMS ☒ SEWER SYSTEMS ☐

DATE APPROVED: 8-22-06

APPROVED BY: [Signature]

APPROVED FOR: [Signature]

Distribution Lines



4. The engineer or owner's agent shall observe all pipe installed in the trench before backfilling.
5. The system shall be installed, tested, and sterilized in accordance with these specifications.

#### *1.4 Quality Assurance*

- A. Polyvinyl chloride (PVC) pipe shall be class 200 PVC-SDR 21 conforming to ASTM D-2241, ASTM D-1785 and AWWA C-900 NSF approved for pipes 12" in diameter and smaller. PVC pipe shall conform to AWWA C905 for pipes 14 inches through 48 inches in diameter. Installation and bedding per detail. Thrust blocking per detail.
- B. Ductile iron pipe (DIP) furnished will be designed, manufactured, and tested in accordance with the AWWA specifications A-21.50 and A-21.51. Ductile iron pipes shall be AWWA "C150 & C151". "Push on" type joints are acceptable unless noted otherwise on the drawings.
- C. Steel pipe shall be AWWA C200 or ASTM A53 or A120.
- D. HDPE pipe material shall be in accordance with AWWA C906.
- E. Underground valves to be class 150 gate valves, cast iron, bronze mounted, non-rising stem with mechanical joint or slip joint ends. All valves to be equipped with cast iron box and cover. All valves shall be Mueller or approved equal. Valves shall conform to AWWA C500, C504, or C509 (latest revision). Each valve shall have a valve protection ring as shown on detail.
- F. All fire hydrants shall conform to AWWA C502 (latest revision).
- G. Each service connection shall consist of ¾" diameter corporation stop with saddle at main connection, Mueller model no. H15009 or approved equal; ¾" polyethylene (iron pipe size) service line, class 160, Yardley or approved equal; for model YM Yoke box ¾" all bronze check valve with hand-wheel operator, both assembled with ¾" diameter brass, all-thread nipples. Gate valve to be assembled with valve box. Install per detail.
- H. Blow-off valves shall be specifically sized to create flushing velocities in the lines on which they are installed. Blow-off installation shall be as shown on detail. The maximum blow-off valve sizes are listed below:  
  
2" dia. – ¾" B.O.V.  
  
2½" dia. – 1" B.O.V.  
  
3" dia. – 1 ¼" B.O.V.

4" dia. – 1 ½" B.O.V.

6" dia. – 2" B.O.V.

- I. All tees, bends, plugs and hydrants on lines 2.5 inches in diameter and larger shall be provided with reaction blocking, tie rods, etc. All cast iron mechanical joints shall be in accordance with ANSI specifications A21.10 and the iron will comply with requirements of ASTM A48, class 25. Metal thickness will conform to AWWA C110. All ductile iron fittings shall comply with ANSI Specifications A21.11.
- J. Detectable marking tape: All water lines shall be marked 12" under finished grade with a high intensity, color-coded warning ribbon for the entire length of the pipe. The ribbon shall be installed as directed by the manufacturer. The ribbon shall be 2" wide composed of a solid aluminum foil core encased in a protective plastic jacket. The color shall be safety precaution blue and shall have "caution water line buried below" printed on the tape for its entire length. The tape shall be manufactured by Allen Systems, Lineguard, Inc. or equal. All water mains shall be detectable within 3 feet with electronic locating equipment. Non-metallic pipes shall be installed with copper wire or other means of detection.
- K. Any pipe solder or flux which is used in the installation or repair of any public water system, used in any plumbing which provides water through connection to a public water system, or provides water for human consumption shall be lead free. Lead free for solder or flux means those containing not more than 0.2% lead. Lead free for pipes and pipefittings means those containing not more than 8.0% lead. Leaded joints necessary for repair of CIP shall be exempt from the above requirements.
- L. All pipe, fittings, packing, jointing materials, valves and fire hydrants shall conform to Section C of the AWWA Standards.
- M. Water mains that have been previously used for conveying potable water may be reused provided they meet applicable criteria from AWWA Section C, ANSI/NSF 61, and ASTM D1785 or D2241. The mains must be thoroughly cleaned and restored practically to their original condition.
- N. Asbestos cement pipe shall not be used in potable water systems except in the repair of existing asbestos cement lines.
- O. Thermoplastic pipe shall not be used above grade.
- P. The use of solvent-weld PVC pipe and fittings in water mains 4 inches and larger is prohibited.
- Q. No flushing device shall be directly connected to any sewer.

- R. Air relief valves shall be provided at high points as required. Automatic air relief valves shall not be used in situations where flooding of the manhole or chamber may occur.

## 2 EXECUTION

### *2.1 General*

- A. Contractor must examine the areas and conditions under which water piping system work is to be installed and notify the engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until notified by the engineer.
- B. Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
- C. Inspect piping before installation to detect any apparent defects. Mark defective materials with white paint and promptly remove from the site.
- D. Install gaskets in accordance with the manufacturer's recommendations for the use of lubricants, cements, and other special installation requirements. Natural rubber or other material which will support microbiological growth may not be used for any gaskets, O-rings, and other products used for jointing pipes, setting meters or valves, or other appurtenances which will expose the material to the water.
- E. Pipe installation: Install all pipe in strict accordance with pipe manufacturer's written instructions.
- F. Pipe handling and stockpiling: Stockpile pipe within areas designated by the engineer so that no dangerous conditions will exist to life or property. Store pipe so that damage to surfaces and/or structures will be prevented. Provide suitable means of pipe support when lifting.
- G. Fire sprinkler systems and dedicated fire lines, except those in the high hazard category shall be protected by an approved double check valve assembly.
- H. Lubricants that will support microbiological growth shall not be used for slip-on joints. The use of shortening to lubricate joints is prohibited.
- I. All material or products which come into contact with drinking water shall be certified by a third party as meeting the specifications of the American National Institute/National Sanitation Foundation Standard 61, Drinking Water System Components – Health Effects. The certifying party shall be accredited by the American National Standards Institute.
- J. Disinfection of new water mains shall conform to AWWA C651.R.61-58.4 (D)(11)(f) list one method.

- K. Water mains shall be located out of contaminated areas, unless using pipe materials that will protect (i.e., DIP with chemical resistant gaskets). Re-route line if possible.
- L. No water pipe shall pass through or come in contact with any part of a sewer manhole. Water lines may come in contact with storm sewers or catch basins if there is no other practical alternative, provided that ductile iron is used, no joints of the water line are within the storm sewer or catch basin, and the joints are located as far as possible from the storm sewer or catch basin.
- M. Potable water lines shall not be laid less than 25 feet horizontally from any portion of a wastewater tile-field or spray-field, or shall be otherwise protected by an acceptable method approved by SCDHEC.

## *2.2 Pipe Trench Excavation*

- A. All pipe trench excavation shall be “unclassified”.
- B. The trench shall be excavated by an approved method to a depth to permit installation of the pipe along the lines and grades shown on the drawings. The width of the trench shall be sufficient to allow thorough compacting of the backfill under and around the pipe, and in no case shall be less than 18 inches greater than the outside diameter of the barrel of the pipe. Where excavation is in rock, the rock shall be removed to depth below grade of at least 4 inches for pipes smaller than 30 inches in diameter, and 6 inches for pipes 30 inches in diameter and larger. Before laying the pipe, the trench shall be refilled to grade with sand, gravel, or other suitable material firmly compacted to provide proper bedding for the pipe.
- C. Bell holes shall be excavated accurately to size.
- D. All changes of direction shall be made by pipe joint deflection, unless otherwise shown. Maximum deflection for pipe joints shall be in accordance with manufacturer’s recommendations. All intersecting lines shall connect with standard fittings.
- E. The amount of trench excavated ahead of pipe shall be subject to approval of the engineer.
- F. The contractor shall perform all necessary bracing and bridging to maintain traffic during construction through areas affecting by trenching.

## *2.3 Street Crossing – Omit*

## *2.4 Bracing, Sheet piling, and Shoring – Omit*

## *2.5 Pipe Bedding*

- A. The bottom of trenches shall be shaped in undisturbed soil, in material placed due to the excavation of muck, or in the bedding required on the drawing.
- B. The entire bottom of the excavation shall be firm, stable, and at a uniform density and unless removal of rock or muck is required, left undisturbed. Joint holes shall be excavated by hand to the minimum size required for proper installation of the joint so that the joint does not carry the weight of the pipe.
- C. Preparation of the trench bottoms, including the required excavation and tamped backfill, shall be performed according to Class A, Class B, or Class C Bedding.

Class A Bedding: Class A Bedding shall consist of concrete cradles poured to the full width of the trench pipe and laid to line and grade on concrete or wood blocking, and joints shall be made before the concrete is poured.

Class B Bedding: Class B Bedding shall consist of an approved, compacted, crushed stone bedding material placed under and around the pipe as shown on the plans. The bedding material shall extend for the full width of the trench.

Class C Bedding: Class C Bedding shall be shaped trench bottom with bell holes.

- D. Continuous and uniform bedding shall be provided in the trench for all buried pipe.
- E. Back-fill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe.
- F. Stones, other than crushed bedding, shall not come in contact with the pipe and shall not be within 6 inches of the pipe.

## *2.6 Pipe Laying*

- A. All pipe shall be laid in the presence of the engineer or owner's agent.
- B. A 10' edge-to-edge horizontal separation shall be maintained between water and existing or proposed sewer lines. Where the horizontal separation cannot be met or where water and sewer lines must cross and with prior approval from SCDHEC, an 18" vertical separation of water over sewer must be maintained. Water line must be laid in a separate trench or on an undisturbed shelf on one side of trench. Where the above conditions cannot be met, see R.61-58.4.0 (12) water and sewer lines shall be cast iron pipe with joints staggered such that maximum separation between joints exist. The water line shall be installed over the sewer line. SCDHEC approval is required prior to installation.
- C. Crossings: Water mains crossing sewers shall be laid to provide a minimum vertical separation of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case whether the water main is either



above or below the sewer line. Whenever possible, the water main shall be located above the sewer line. Where a new water main crosses a new sewer line, a full length of pipe shall be used for both the water main and sewer line and the crossing shall be arranged so that the joints of each line will be as far as possible from the point of crossing and each other. Where a new water main crosses an existing sewer line, one full length of water pipe shall be located so both joints will be as far from the sewer line as possible. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer line to prevent damage to the water main.

- D. Special Conditions: When it is impossible to obtain the distances specified in R.61-58.4(D)(12)(a) and (b), SCDHEC may allow an alternative design. Any alternative design shall:
- a. maximize the distances between the water main and sewer line and the joints of each;
  - b. use materials which meet the requirements of R.61-58.4(D)(1) for the sewer line; and,
  - c. allow enough distance to make repairs to one of the lines without damaging the other.
- E. Force Mains: There shall be at least a 10-foot horizontal separation between water mains and sanitary sewer force mains. There shall be an 18 inch vertical separation at crossing as required in R.61-58.4(D)(12)(a) and (b).
- F. Proper implements, tools, and facilities satisfactory to the engineer shall be provided and used by the contractor for safe installation of the work.
- G. All foreign matter and dirt shall be cleaned from the inside of pipe and valves before lowering into position in the trench, and they shall be kept clean during and after laying.
- H. During times when pipe laying is not in progress, the open ends of pipe shall be closed and no trench water shall be permitted to enter the pipe.
- I. Cutting of pipe for intersecting valves, fittings or other closure pieces shall be done in a neat and workmanlike manner without damage to the pipe.
- J. No pipe shall be laid in water, or when trench conditions or weather is unsuitable for such work, except by permission of the owner's representative.
- K. Before laying pipe, the bottom of the trench shall be prepared to provide uniform and substantial bearing throughout the length of the pipe. In firm ground, the pipe shall be laid upon the graded bottom of the trench. In ground that is not otherwise sufficiently firm to support the pipe, crushed stone or gravel shall be

worked into the bottom of the trench until the necessary degree of firmness is obtained, as approved by the owner's representative.

- L. Before lowering pipe into trenches, each section of pipe shall be thoroughly inspected, particularly ends, for damage that may affect the strength of the pipe and suitability of the joint. Defective or damaged pipe shall be rejected.
- M. Pipe shall be laid with bell ends facing in the direction of pipe laying, unless directed otherwise by the engineer. Where pipe is laid on a grade of 10 percent or greater, the laying shall start at the bottom of the slope and proceed upward with the bell ends of the pipe upgrade. All pipe sleeves or double hubs required to connect pipe when laying to a junction from opposite directions, when done so as the contractor's option to facilitate pipe laying, shall be furnished and installed at the contractor's expense.
- N. Cutting of pipe for inserting valves, fittings, or other closure pieces shall be done in a neat and workmanlike manner without damage to the type.
- O. All water mains shall have a minimum cover of 30" unless pipe material is steel, concrete, DIP, or other approved material, and insulated to prevent freezing.
- P. All water mains shall be provided with a minimum of 30 inches of cover, unless pipe material is steel, concrete, DIP, or other approved material, and if exposed shall be insulated to prevent freezing.
- Q. For above-water crossings, the pipe shall be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement.
- R. For under-water crossings, a minimum of 2 feet of cover shall be provided over the pipe. When crossing water courses that are greater than 15 feet in width, the following shall be provided:
  - 1. The pipe material and joints shall be designed appropriately.
  - 2. Valves shall be located so the section can be isolated for testing or repair; the valves (on both sides of the crossing) shall be easily accessible and not subject to flooding.
  - 3. A blow-off shall be provided on the side opposite the supply service sized in accordance with Section R.61-58.4 (D)(7). Direct away from streams, over ground.
  - 4. Use DIP with mechanical joints for any lines being installed in rock.

## *2.7 Setting Appurtenances*

- A. All valves and fittings shall be set in manner conforming to the methods specified cleaning and laying and joints shall be made as specified herein before

for the applicable conditions. Wherever flange joints are required, the contractor shall furnish and install all jointing material required for making joints in accordance with the best practice for such work. Operating nuts on valves shall extend to within 6 inches of grades.

- B. Cast iron valve boxes shall be firmly supported, and maintained centered and plumb over the wrench nut of the gate valve, with box cover flush with the surface of the finished grade or at such other level as may be directed.
- C. Drainage branches or blow-off shall not be connected to any sewer, submerged in any stream or installed in any other manner that will permit back-siphonage into the system.
- D. Chambers, pits or manholes containing valves, blow-offs, meters, air relief valves, or other such appurtenances to a distribution system, shall not be connected directly to any storm drain or sanitary sewer.
- E. Installation of water mains and appurtenances shall be conducted in accordance with Section C of the AWWA Standards and/or manufacturer's recommended installation procedures.

#### *2.8 Pumping:*

- A. The contractor shall do all pumping necessary for dewatering trenches and to provide proper conditions for installation of pipe and appurtenances.

#### *2.9 Pipe Anchorage Method:*

- A. At all bends, tees, whenever shown and as described on drawings, provide a concrete mass, of sizes required for test pressures, poured against firm natural earth, to act as thrust block anchor.
- B. The concrete shall be 3000 lb. Concrete approved by the engineer.
- C. Wherever shown and described on the drawings, anchorage against thrust shall be accomplished by the use of tie rods. Where bends, tees, or other fittings are to be anchored to slip joint pipe, socket clamps shall be used behind the bells to provide tie rod fastening. All bends, tees and fittings tied accordingly shall be anchored by two tie rods for at least one full (20 ft.) pipe length. Where short lengths of pipe are used to make up fittings or plugged ends, the tie rods shall be extended to the end of the next full length of pipe.
- D. All tie rods, socket clamps, and socket shall be given a coat of asphalt paint after installation and prior to backfilling of the trench.

#### *2.10 Backfilling:*

- A. Immediately after the pipe has been laid, the trench shall have a controlled backfill placed around the barrel of the pipe with fine material, free of large stones, deposited in level layers not more than 6 inches in depth. Each layer shall be thoroughly mechanically tamped and compacted before the next layer is deposited.
- B. The contractor shall have, subject to the approval of the engineer, the option of applying the specified hydrostatic pressure test to pipe in an open trench or to pipe in a backfilled trench. If the contractor elects to backfill pipe trenches before testing, he shall not be relieved from locating points of excessive leakage and making all necessary repair to joints, replacing pipe and other corrective work. The engineer shall have the right to withdraw his approval for pressure testing pipe after backfilling pipe trenches at any time if in his judgment this practice is not in the best interest of the owner and quality of the completed project.
- C. For pressure testing pipe in open trenches, the backfill shall be made along the barrel of pipe only, and to a level between the mid-diameter of the pipe and the top of the pipe. Backfill shall be kept away from the joints during testing and until after all joint or other repairs have been successfully made.
- D. Controlled backfill, using fine material, shall be placed up to 18 inches above top of pipe in 6-inch layers and thoroughly mechanically tamped. Remaining backfill may be placed in 12-inch to 18-inch lifts and compacted by backfiller or hydra-hammer, all subject to approval by the owner's representative. Where pipeline is located under paved roads or streets or within the right-of-way of public thru-fares, the backfill shall be consolidated in such a manner as to provide an unyielding foundation with excess materials removed.
- E. Succeeding layers or backfill above the controlled backfill may contain coarser materials, and shall be free from brush or any other perishable or objectionable matter that would prevent proper consolidation or that might cause subsequent settlement, and shall be compacted thoroughly by mechanical tampers.
- F. No stone larger than 6 inches in its greatest dimension shall be used in any part of the backfilling.
- G. Where it is important that the surface of the backfill be made safe for vehicular traffic as soon as possible or, where permanent pavement is to be placed within a short time, the upper 12-inches of backfill shall be of approved moist material thoroughly compacted in thin (4-inch) layers by tamping, and shall be brought to the required surface grade.
- H. Any deficiency in the quantity of material for backfilling the trenches, or for filling depressions caused by settlements shall be supplied by the contractor.
- I. The contractor shall replace all existing paving, utilities, and other features which are damaged by the work or the contractor's operations under this contract

to the satisfaction of the engineers and in accordance with details on plans or with requirements by governing official bodies. In no case shall the replacement be of less quality or quantity than the original installation.

- J. With respect to the contractors-owner-public relationship that inherently exists in utility work, the following shall apply during the course of this project.
- The owner will obtain all easements, encroachment permits, deeds and other permanent access rights for access necessary for the completed project. Also, other rights for access and storage during construction shall be obtained by the owner through private property owners.
- K. With respect to existing underground utilities, the following shall apply during the course of this project.
- Special precautions shall be taken by the contractor to avoid damage to existing overhead and underground utilities owned and operated by the owner or by public or private utility companies.
  - With particular respect to existing underground utilities, all available information concerning their location has been shown on the plans. While it is believed that the locations shown are reasonably correct, neither the engineer nor the owner can guarantee the accuracy or adequacy of this information.
  - Before proceeding with the work, the contractor shall confer with all public or private companies, agencies, or departments that own and operate utilities in the vicinity of the construction work. The purpose of the conference or conferences, shall be to notify the said companies, agencies, or departments of the proposed construction schedule, verify the location of and possible interference with the existing utilities that are shown on the plans, arrange for necessary suspension of service, and make arrangements to locate and avoid interference with all utilities (including house connections) that are not shown on the plans. The engineer and owner have no objection to the contractor arranging for the said utility companies, agencies, or departments to locate and uncover their own utilities; however, the contractor shall bear the entire responsibility for locating and avoiding or repairing damage to said existing utilities.
  - When existing utilities or appurtenant structure, either underground or above ground, are encountered, they shall not be displaced or molested unless necessary, and in such case shall be replaced in as good or better condition than found as quickly as possible. Permanent or temporary relocation and replacement of all utilities and appurtenant structures to accommodate the construction work shall be the contractor's expense.

- L. Where trenching operations occur on “cultivated” grassed or landscape area, privately or publicly owned, the contractor shall spread the stockpile topsoil and restore said property to its original state.

*2.11 Pipe Joints:*

- A. Pipe joints shall be made up in strict accordance with the manufacturer’s printed recommendations and specifications.

*2.12 Pits and Supports:*

- A. Pits and pipe supports shall be constructed in accordance with detail drawings with materials as specified under other divisions and sections of the work. Frames and covers shall be of sizes and types indicated on drawings.

*2.13 Pressure and Leakage Tests:*

- A. After the pipe has been laid and backfilled or partially backfilled (contractor’s option in accordance with these specifications), each valved section of pipeline shall be subjected to hydrostatic and leakage tests in accordance with the applicable requirements of AWWA C600, latest edition.
- B. Before applying the test, all air shall be expelled from the pipe. Each valved section of the pipe shall be slowly filled with water and the specified test pressure shall be applied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection and all necessary apparatus and gauges shall make necessary taps into the pipe and shall furnish all work necessary for conducting the test. The engineer shall witness all tests.
- C. Test pressure for the pipeline shall be 200 PSI or 1.5 x maximum working pressure, whichever is greater, supplied for 2-hour minimum duration.
- D. No pipe installation shall be accepted if leakage is greater than:

Allowable leakage shall be calculated using the following formula:

Ductile iron:

$$L = \frac{SD(P)^{1/2}}{133,200}$$

PVC:

$$L = \frac{ND(P)^{1/2}}{7,400}$$

L=ALLOW LEAKAGE (GAL/HR)

S=LENGTH OF PIPE IN FEET

D=NOMINAL PIPE DIAMETER

P=AVERAGE TEST PRESSURE

N=# OF JOINTS IN PIPELINE BEING TESTED

Note: Actual leakage shall not exceed allowable leakage as calculated by this formula. Defective pipe, joints, fittings, valves, accessories or

workmanship shall be removed or corrected. Tests shall be repeated until results are satisfactory to the engineer.

E. All visible leaks shall be repaired regardless of the amount of leakage.

*2.14 Sterilized Pipe Lines:*

- A. Before being placed in service and after the hydrostatic tests are completed, all pipe and fittings installed under this contract shall be sterilized. Contractor shall furnish all equipment and materials necessary to do the work.
- B. All rules and regulations of the SCDHEC shall be complied with and as outlined in AWWA designation C651, latest edition.
- C. Prior to sterilization, all dirt remaining in pipe after its completion shall be removed by a thorough flushing out. This may be done either or after the trench shall have been backfilled, but after the pressure test. Each valved section of newly laid pipe shall be flushed independently.
- D. Water from any existing distribution system or any completed extension of it entering the newly laid pipe line, shall be controlled to flow slowly during the application of chlorine. The dosage of chlorine shall be in such proportion to the rate of water flowing through the pipe that the treated water entering the newly laid pipe shall have a concentration of residual chlorine not less than 25 milligrams per liter.
- E. Disinfection of all new water mains shall be in accordance with current American Water Works Association (AWWA) Standard C651 for the disinfection of water mains. In general, one approved method referred to as "continuous feed method" is as follows:
  - a. Before being placed in service, all new mains shall be thoroughly flushed then chlorinated with not less than twenty-five (25) milligrams per liter of available chlorine.
  - b. Water from the existing distribution system or other source of supply shall be controlled so as to flow slowly into the newly laid pipeline during the application of chlorine.
  - c. The solution shall be retained in the pipeline for not less than twenty-four (24) hours and then flushed thoroughly with a potable water of satisfactory bacteriological quality before starting the sampling program.
- F. Backflow in the pipe being treated shall be prevented.
- G. In the process of sterilization of newly laid water pipe involving more than one valved section, all valves or other appurtenances shall be operated while the pipe line is filled with the sterilization agent.

- H. Following sterilization, all treated water shall be thoroughly flushed from the newly laid pipeline at its extremities until the residual chlorine content does not exceed 0.2 PPM. The contractor shall dispose of water used in disinfecting and flushing in approved manner. No flushing device shall be directly connected to any sewer. The solution shall be retained in the pipeline for not less than twenty-four (24) hours and then flushed thoroughly with a potable water source of satisfactory bacteriological quality before starting the sampling program.
- I. The contractor shall submit a minimum of (2) water quality samples taken from the new line at 24-hour intervals and submit to a state approved lab for testing. Should the initial treatment prove ineffective, the sterilization procedure shall be repeated by the contractor until samples conform to water quality requirements.
- J. The contractor or owner shall collect a minimum of two (2) samples from each sampling site for total coliform analysis. The number of sites depends on the amount of new construction but must include all dead-end lines, be representative of the water in the newly constructed mains, and shall be collected a minimum of every 1,200 linear feet.
- K. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non-detectable in those systems not chlorinating.
- L. These samples must be collected at least twenty-four (24) hours apart and must show the water line to be absent of total coliform bacteria.
- M. The chlorine residual must also be measured and reported.
- N. If the membrane filter method of analysis is used for the coliform analysis, non-coliform growth must also be reported.
- O. If the non-coliform growth is greater than eighty (80) colonies per one hundred (100) milliliters, the sample result is invalid and must be repeated.
- P. All samples must be analyzed by a State certified laboratory.

*2.15 Cross Connection Control (Backflow Prevention Devices)*

- A. There shall be no connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water or other contamination materials may be discharged or drawn into the system.
- B. No bypasses shall be allowed, unless the bypass is also equipped with an equal, approved back-flow prevention device.
- C. High hazard category cross connections shall require an air gap separation or an approved reduced pressure backflow preventer.



- D. Reduced pressure principal backflow prevention assemblies shall not be installed in any area location subject to possible flooding. This includes pits or vaults that are not provided with a gravity drain to the ground's surface that is capable of exceeding the discharge rate of the relief valve. Generally, if installed in a pit, the drain line shall be 2 times the size of the line entering the backflow prevention device. The drain cannot empty into any type of ditch, storm drain, or sewer, which could flood water back into the pit.
- E. All piping up to the inlet of the backflow prevention device must be suitable for potable water. The pipe must be AWWA or NSF approved. Black steel pipe cannot be used on the inlet side of the device.
- F. Fire line sprinkler systems and dedicated fire lines, except those in high hazard category shall be protected by an approved double check valve assembly.

*2.16 Field Coating:*

- A. All tie rods, clamps and structural steel members shall receive one coat, eight mils dry film thickness, of Amercoat no. 79, or approved equal. Coatings application shall be in accordance with the manufacturer's recommendations.

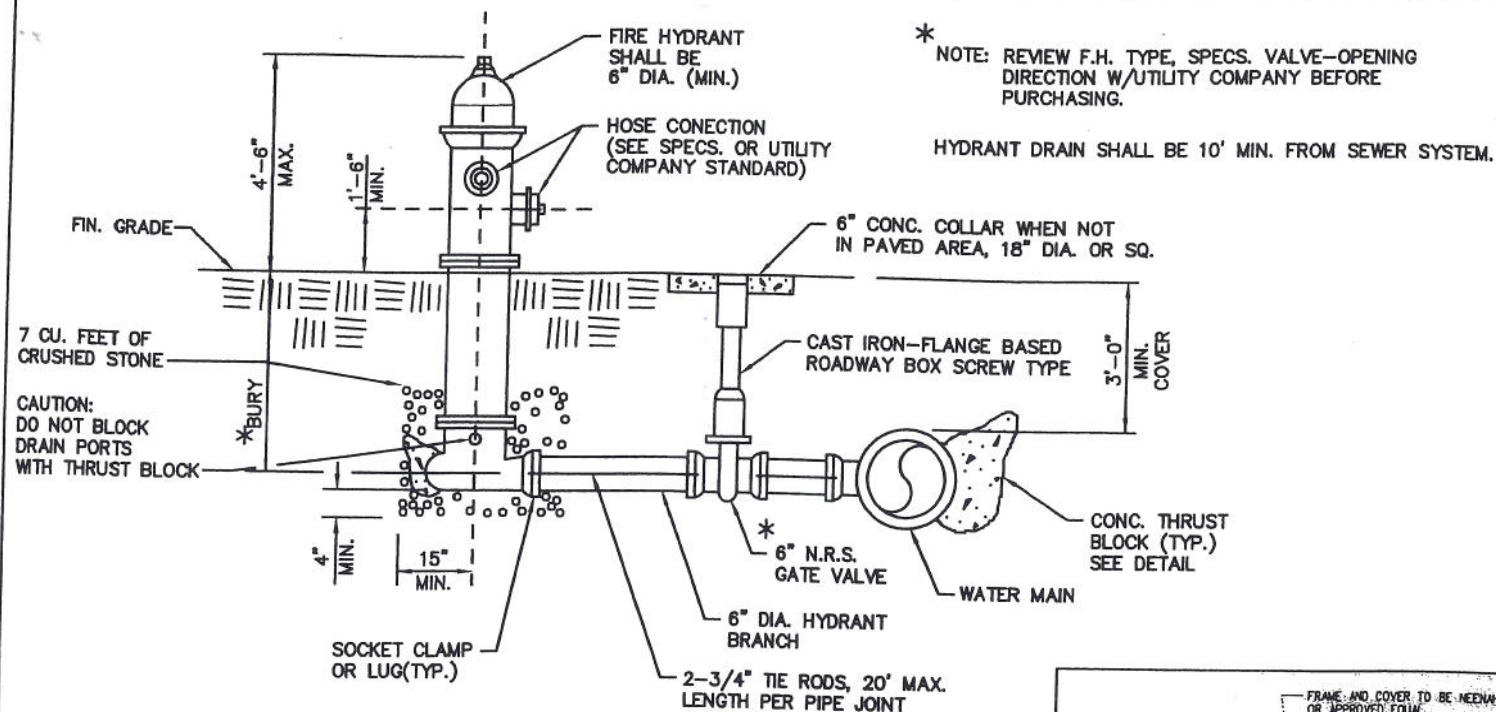
*2.17 Pavement Replacement:*

- A. All concrete sidewalks, asphalt pavement and curb gutter that is removed or damaged by construction shall be restored and replaced with new materials to at least the original condition as detailed on the drawings and to the satisfaction of the South Carolina Department of Highways and Public Transportation.

*2.18 Clean-up:*

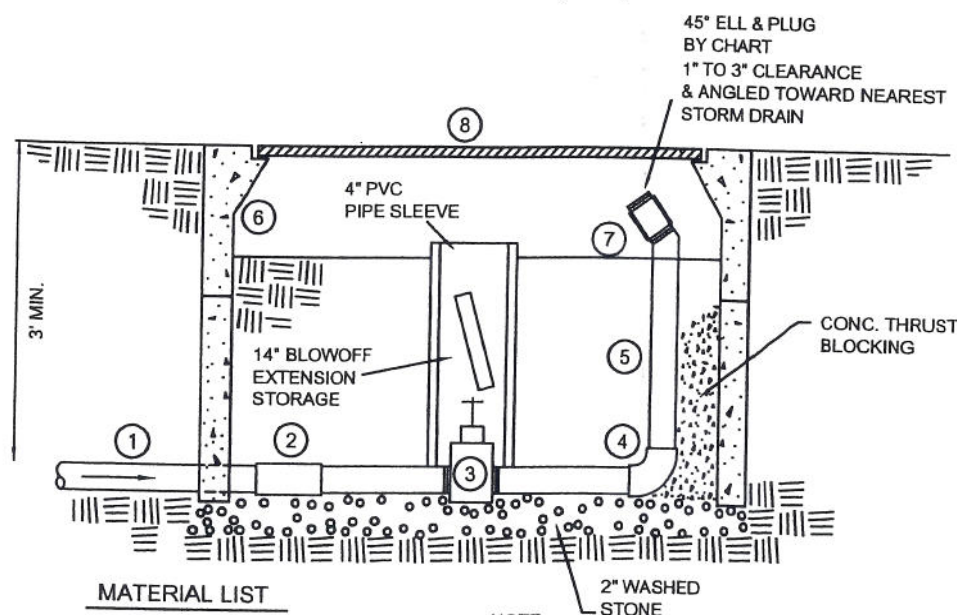
- A. The contractor shall remove all excess material from excavations and clean the work site of all debris collected during construction.

End of Section 2G2



TYPICAL FIRE HYDRANT

(N.T.S.)



MATERIAL LIST

- 1 - END OF WATER LINE (SEE PLAN FOR SIZE)
- 2 - EXIST. W.L. DIAMETER X ADAPTER
- 3 - 2" VALVE; 2"x3" NIPPLE
- 4 - 2" ELBOW
- 5 - THREADED COUPLING W/ REDUCER FITTINGS AND PLUG TO MATCH BLOW-OFF SIZE INDICATED ON DRAWINGS.
- 6 - BROOKS CONCRETE METER BOX (2 PIECES; 12" & 15")
- 7 - BLOW-OFF PIPE WITH 90° BEND TO MATCH INDICATED SIZE (SHOWN ON BLOW-OFF SCHEDULE)
- 8 - CAST IRON LID.

NOTE: ALL PIPE & FITTINGS SHALL BE SCHEDULE 80

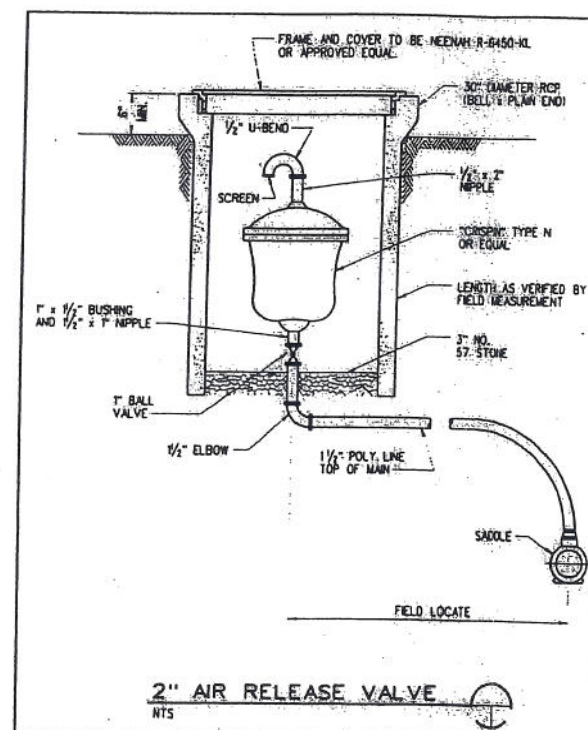
PIPE & BLOW-OFF SCHEDULE

PIPE DIA.(IN.)	BLOW-OFF SIZE(IN.)
2"	3/4"
2 1/2"	1"
3"	1 1/4"
4"	1 1/2"
6"	2"
8"	2 1/2"
10"-12"	FIRE HYDRANT
14"-16"	SPECIAL BLOW-OFF

BLOW-OFF DETAIL

(N.T.S.)

NOTE: BLOW-OFFS SHALL NOT BE DIRECTED TOWARD ROADS OR SO THAT THE WATER WILL FLOW INTO CREEKS, ETC. AT STREAM CROSSINGS, DIRECT AWAY FROM STREAMS, OVER GROUND.



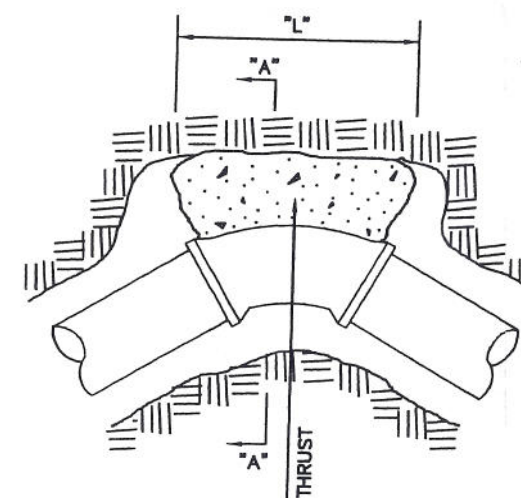
FIELD ADJUSTMENT INSTRUCTIONS

1. REMOVE THE BODY FROM THE TOP OF THE INDICATOR POST ASSEMBLY.
2. CUT THE REQUIRED LENGTH OFF THE BOTTOM OF THE STANDPIPE FOR THE GROUND LINE TO MATCH UP WITH STANDPIPE GROUND LINE MARK.
3. CUT THE 1" SQ. EXTENSION AT A DISTANCE OF 6" ABOVE THE TOP OF THE STANDPIPE.
4. SET THE "OPEN" AND "SHUT" TARGETS FOR THE APPROPRIATE VALVE SIZE.
5. RE-ATTACH THE BODY TO THE TOP OF THE INDICATOR POST ASSEMBLY.
6. ALL PIV(s) SHALL BE INSTALLED WITH AN ELECTRONICALLY CONTROLLED TAMPER SWITCH.

NOTE:

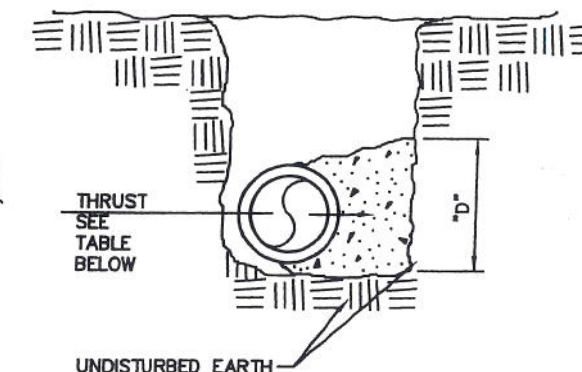
POST INDICATOR VALVE SHALL BE LOCATED AT A MINIMUM 5'-R FROM BUILDING

STANDARD TAPPING SLEEVE & POST INDICATOR VALVE



PLAN

NOTE: THRUST BLOCKING SHALL BE 3,000 LB. CONCRETE, PROPERLY PLACED, TO TRANSMIT FORCES TO UNDISTURBED EARTH AS INDICATED.



ELEVATION

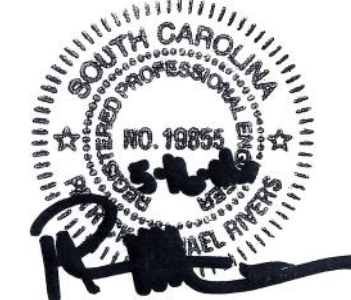
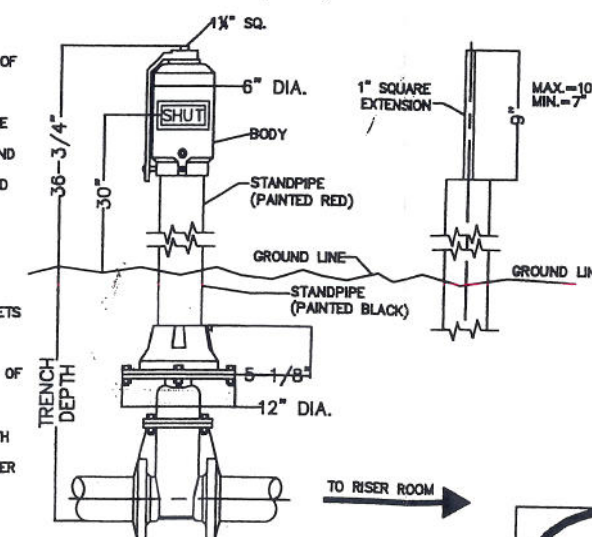
THRUST TABULATION (KIP)

BEND PIPE DIA.	BEND 22-1/2°	BEND 45°	BEND 90°	PLUG TEE OR 60° BEND
2"-4"	0.7	1.3	2.5	4.7
6"	1.5	2.9	5.7	10.6
8"	2.9	5.0	9.8	18.2
10"	3.8	7.5	14.8	27.4
12"	5.4	10.7	20.9	38.7
14"	7.4	14.6	28.6	52.8
16"	9.3	18.5	36.4	67.2

$$\text{END AREA SQ. FT.} = \frac{\text{THRUST} \times 1000}{\text{BEARING} \times 2000}$$

THRUST BLOCK DETAIL

(N.T.S.)





## SECTION 33 30 00 - SANITARY SEWERAGE

### 1.1 SUMMARY

- A. This section includes sanitary sewer piping and related appurtenances from connection to main to within 5 feet of outside the building limits.
- B. All work shall conform to the requirements of the local sewer authority and any other regulatory authorities having jurisdiction, or this specification, whichever is more stringent.
- C. Do not put into operation until all testing and approvals have been received.
- D. Contractor to provide as-built PDF and CAD file including all sanitary sewer data by a licensed surveyor. Reference Survey and Layout specification section for information on necessary as-built to be provided by the Contractor.

### 1.2 REFERENCED SECTIONS

- A. Section 31 23 17 – Trenching and Excavation
- B. Section 31 20 00 – Earth Moving

### 1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
  - 1. A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe
  - 2. D3034 - Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings
  - 3. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
  - 4. F679 - Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
  - 5. C476 - Standard Specification for Grout for Masonry
  - 6. C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
  - 7. C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
  - 8. D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
  - 9. C478 – Standard Specifications for Precast Reinforced Concrete Manhole Sections
  - 10. C969 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
- B. American Society of Sanitary Engineers (ASSE)
- C. American National Standards Institute (ANSI)
- D. American Concrete Institute (ACI)
  - 1. 318 - Building Code Requirements for Structural Plain Concrete
- E. National Sanitation Foundation (NSF)
- F. American Water Works Association (AWWA)
  - 1. C110 - Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (75 mm through 1200 mm), for Water and Other Liquids (revision of ANSI/AWWA C110/A21.10-93)
  - 2. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings C153 - Ductile-Iron Compact Fittings, 3 in. through 24 in. (76 mm Through 610 mm) and 54 in. through 64 in. (1,400 mm Through 1,600 mm), for Water Service (revision of ANSI/AWWA C153/A21.53-94)
  - 3. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances (revision of ANSI/AWWA C600-93)
  - 4. C150 – ANSI Standard for Thickness Design of Ductile Iron Pipe
  - 5. C151 – ANSI Standard for Ductile Iron Pipe

- 6. C153 – ANSI Standard for Ductile Iron Pipe Compact Fittings
- G. Federal Specifications
  - 1. SS-S-00210 – Sealing Compound Preformed Plastic for Pipe Joints
- H. Uni-Bell PVC Pipe Association
  - 1. UNI-B-6 - Low-Pressure Air Testing of Installed Sewer Pipe
- 1.4 PERFORMANCE REQUIREMENTS
  - A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.
  - B. Force-Main Pressure Ratings: At least equal to system operating pressure, but not less than 150 psig.
  - C. All sanitary sewer piping must be installed true to line and grade of the design. Clearly specify any allowable tolerances in these installations and insist on adherence to these tolerance values.
- 1.5 QUALITY ASSURANCE
  - A. Regulatory Requirements: Comply with requirements of the regulatory authorities having jurisdiction; including tapping of sewer mains, installation, and testing.
  - B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
  - C. Comply with requirements of Section 31 23 17, Trenching and Excavation.
- 1.6 SUBMITTALS
  - A. The General Contractor and the Subcontractor shall execute the Conformance Submittal(s) at the end of this section.
- 1.7 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 the Owner not less than two days in advance of proposed utility interruptions; and,
    - 2. Do not proceed with utility interruptions without written permission from the Owner.
  - B. Removal/Relocation of Existing Utilities: The contractor shall be responsible for removal and/or relocation of existing utilities, whether shown or not shown on the drawings, at locations where conflicts occur with proposed sanitary sewer improvements at no additional cost to the owner.
  - C. All new construction and any renovation that establishes labeling conventions for nonelectric utilities shall follow the standards set forth in the most recent version of ANSI/ASME 13.1.
  - D. Labels shall indicate the type of utility and direction of flow on all labels. Labels shall also be no more than 20 feet apart. For dual temperature hydronic piping, the standard convention of green with white writing shall be used with labeling as Dual Temp. Supply (DTS) and Dual Temp. Return. (DTR).
  - E. When an existing convention other than the one listed above is present, the existing color-coding system shall be followed for all new work on the system while maintaining the label spacing and direction of flow indication above.
- 1.8 COORDINATION & FEES
  - A. Contractor shall be responsible for obtaining and payment of all tap and construction permit fees associated with this section.
  - B. Contractor shall install all sewer lines and appurtenances as shown on the drawings to within 5 feet of building limits. This shall include any taps, pumps, tanks, etc. If Contractor's work terminates at a connection point where work by others is complete, Contractor shall make the connection. If future connections will be required by others, Contractor shall install plugging and marking apparatus as necessary to protect, identify and locate his work.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. PVC Sewer Pipe and Fittings: 12 inches and smaller: ASTM D 3034, SDR 35, elastomeric gasket joints per ASTM F477 and ASTM D3212.
- B. PVC Sewer Pipe and Fittings: 15 inches and larger: ASTM F 679, SDR 35, Type T-1, elastomeric gasket joints per ASTM F477 and ASTM D3212.
- C. Ductile-Iron Sewer Pipe and Fittings: ASTM A 746, AWWA C110, AWWA C111, AWWA C150, AWWA C151, AWWA C153, for push on joints.

### 2.2 MANHOLES

- A. Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints, and pipe boots.
  - 1. Inside diameter: 48 inches minimum, unless otherwise indicated;
  - 2. Base Section: 8 inches minimum thickness for floor slab and 5 inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor;
  - 3. Riser Sections: 5 inch minimum thickness;
  - 4. Top Section: Eccentric-cone type, unless otherwise indicated;
  - 5. Gaskets: ASTM C 443, rubber (When required by local authority having jurisdiction);
  - 6. Steps: 16 inches on centers, ASTM C 478, for all structures over 3 feet 6 inches in height;
  - 7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section; and,
  - 8. Joints of the manhole sections shall be of the tongue and groove type, filled with an approved preformed butyl rubber base, sealing compound, conforming to Federal Specifications SS-S210A, Type 1, Rope form.
- B. Standard manhole frames and covers: shall conform to the standard detail of the regulatory authorities having jurisdiction for the project (if applicable). Otherwise, manhole frames and covers to be Neenah Foundary Co. No. R-1642 or Vulcan Foundary Inc. No. V-1357.
- C. All sanitary sewer manhole covers shall have the word "SANITARY SEWER" cast on the top in letters 2 inches high.

### 2.3 FITTINGS

- A. Tyler Union Mechanical Joint Fittings and EBAA Iron Restraint Joint System to be used.

### 2.4 LINING

- A. Protecto 401 ceramic epoxy lining to be used on all ductile iron sanitary sewer pipes according to manufactures specifications.

### 2.5 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, 4,000 psi

### 2.6 CLEANOUTS

- A. Cleanouts shall be provided on sewer service laterals as shown on the plans or at no more than 100' on centers. Exterior cleanout plug shall be US Foundry cover USF 7621 or equal. Each cleanout plug shall be level with adjacent grade and provided with a 24 inches by 24 inches square, 8 inch thick concrete apron. If cleanouts fall within a sidewalk, entire clean out shall be within sidewalk.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Excavating, trenching, and backfilling are specified in Section 31 2317 Trenching and Excavation.
- B. Identification: Materials and their installation are specified in Section 31 2000 – Earth Moving. Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.
  - 1. Use warning tape or detectable warning tape over ferrous piping; and,
  - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.
- C. Piping Applications: Include watertight joints.
- D. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- E. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- F. Install gravity-flow piping to within 5 feet of the building, at the building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.
- G. Install piping at slope shown on the drawings. If no slope is shown, minimum slope shall be 1% for 6 inch diameter pipes and 0.5% for 8 inch diameter pipes.
- H. Install piping with 36 inch minimum cover.
- I. Pipe Joint Construction and Installation: Join and install pipe and fittings according to installations indicated.
  - 1. PVC Sewer Pipe and Fittings: Install according to ASTM D 2321; and,
  - 2. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.
- J. Manhole Installation: Install complete with appurtenances and accessories indicated.
  - 1. Form continuous concrete channels and benches between inlets and outlet; and,
  - 2. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.
- K. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- L. Clear interior of piping and structures of dirt and superfluous material as work progresses.
  - 1. Place plug in end of incomplete piping at end of day and when work stops; and,
  - 2. Flush piping between manholes and other structures to remove collected debris.
- M. Contractor should verify inverts with architectural plans prior to installation.

### 3.2 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. 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 95% of pipe diameter.
    - c. Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from piping.
  - 2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - 3. Reinspect and repeat procedure until results are satisfactory.

- 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 by Clemson, Engineer and SCDHEC Permit to Operate is obtained in the case of Permit to Construct was obtained from SCDHEC;**
  2. Test completed piping systems according to authorities having jurisdiction;
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice;
  4. Submit separate reports for each test to general contractor within 2 days of test;
  5. If authorities having jurisdiction do not have published procedures, perform tests as follows:
    - a. Sanitary Sewerage: Perform hydrostatic test.
      - 1) Allowable leakage is maximum of 50 gal. per inch of nominal pipe size per mile of pipe, during 24-hour period.
      - 2) Close openings in system and fill with water.
      - 3) Purge air and refill with water.
      - 4) Disconnect water supply.
      - 5) Test and inspect joints for leaks.
      - 6) Option: Test ductile-iron piping according to AWWA C600, Section "Hydrostatic Testing." Use test pressure of at least 10 psig.
    - b. Sanitary Sewerage: Perform air test according to UNI-B-6.
      - 1) Manholes: Perform hydraulic test according to ASTM C 969;
      - 2) Leaks and loss in test pressure constitute defects that must be repaired; and,
      - 3) Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
    - c. Mandrel Test meeting all SCDHEC requirements.

END OF SECTION 33 30 00

**CONFORMANCE SUBMITTAL**

**SECTION 33 3000 – SANITARY SEWERAGE**

Project: \_\_\_\_\_  
(City, State)

General Contractor: \_\_\_\_\_  
(Company Name, Phone Number)

\_\_\_\_\_  
(Address)

Sub-Contractor: \_\_\_\_\_  
(Company Name, Phone Number)

\_\_\_\_\_  
(Address)

---

The following products have been selected (check one box) for use in this project from the list of acceptable products specified:

Piping Materials:

- ☐ Ductile-Iron Pipe, ASTM A746
- ☐ Polyvinyl Chloride (PVC) Pipe, ASTM D3034, SDR 35, Elastomeric Gasket Joints ASTM F477
- ☐ Other per AHJ: \_\_\_\_\_

Manholes:

- ☐ Precast with Cored or Cast Holes with Properly Sized Boots
- ☐ Other per AHJ: \_\_\_\_\_

---

I represent to Owner that the products selected will be installed in compliance with the applicable codes for the authorities having jurisdiction and in accordance with the contract documents. If noncompliance is discovered the General Contractor shall make or cause to be made all necessary corrections to meet the applicable codes and specifications. Immediately or as directed by Owner the work shall be completed without additional cost to the and / or the contract.

Sub-Contractor: \_\_\_\_\_  
(Signature of the Authorized Agent of the Sub-Contractor) Date

\_\_\_\_\_  
(Print Name of the Authorized Agent of the Sub-Contractor)

General Contractor: \_\_\_\_\_  
(Signature of the Authorized Agent of the General Contractor) Date

\_\_\_\_\_



*(Print Name of the Authorized Agent of the General Contractor)*

SANITARY SEWER CERTIFICATION FORM

<b>Project</b>	
<b>Date</b>	
<b>Engineer</b>	
<b>General Contractor</b>	
<b>Utility Contractor</b>	
<b>Const. Mgr.</b>	

**ENGINEER CERTIFICATION (If required)**

I certify that the sanitary sewer system for the above referenced project has been installed and tested in accordance with local code and Plans and Specifications dated \_\_\_\_\_.

Engineer \_\_\_\_\_

Registration No. \_\_\_\_\_

Affix Seal Here (not valid unless sealed)

Date \_\_\_\_\_

**GENERAL CONTRACTOR CERTIFICATION (Required)**

I certify that the sanitary sewer system for the above referenced project has been installed and tested in accordance with local code and Plans and Specifications dated \_\_\_\_\_.

General Contractor \_\_\_\_\_

License No. \_\_\_\_\_

Date \_\_\_\_\_

**UTILITY CONTRACTOR CERTIFICATION (Required)**

I certify that the sanitary sewer system for the above referenced project has been installed and tested in accordance with local code and Plans and Specifications dated \_\_\_\_\_.

Utility Contractor \_\_\_\_\_

License No. \_\_\_\_\_

Date \_\_\_\_\_

\* Submit this certification form with test results, local certificates, etc.

## Section 2J1 – Underground Sewers and Drainage Lines

### 1 GENERAL

#### 1.1 Related Documents

The general provisions of Division 1 shall govern this section.

#### 1.2 Description of Work

- A. This section includes furnishing all labor, materials, and equipment for the installation of all underground sewer and drainage lines, including manholes, catch basins, concrete piers, and other appurtenances and structures as required for this project.
- B. The layout of underground lines and invert elevations at governing points are shown on the drawings.
- C. All connections and changes of direction shall be made with standard fittings or at manholes or drainage structures as shown on plans.

#### 1.3 Quality Assurance

- A. In addition to the requirements of these specifications, all work shall comply with the requirements to current regulations of the governing authority.
- B. Where special conditions exist, these will be reviewed in the field with the engineer for the determination of a proper solution.
- C. The contractor installing the underground sewer system shall be a firm specializing and experienced in this work for not less than 2 years.

#### 1.4 Related Work Specified Elsewhere

- A. Interior Plumbing
- B. Earthwork and Site Grading

### 2 PRODUCTS

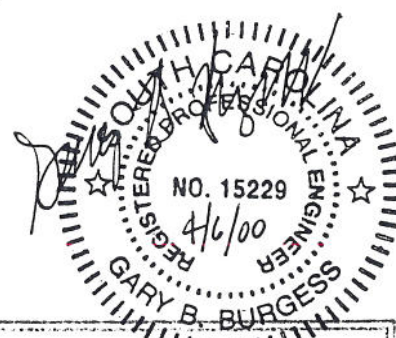
#### 2.1 Materials

- A. Concrete shall be 3000 psi mix using Portland cement (ASTM C150 Type I), sand (ASTM C33), and coarse aggregate (ASTM C33).
- B. Welded wire fabric shall conform to ASTM A185.

**RECEIVED**

APR 10 2000

WATER FACILITIES  
PERMITTING DIVISION



SC DEPT. of Health & Environmental Control	
Bureau of Water	
SPECIFICATIONS APPROVAL	
WATER SYSTEMS <input type="checkbox"/>	SEWER SYSTEMS <input checked="" type="checkbox"/>
DATE APPROVED: 4/13/00	
APPROVED BY: Gina Abbott	
APPROVED FOR: Gravity Lines (PVC, VCP, DIP, CIP, RC)	
Force Mains (PVC, DIP); Manholes (Standard Drop)	

## Section 2J1 – Underground Sewers and Drainage Lines

### 1 GENERAL

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The general provisions of Division 1 shall govern this section.

#### 1.2 Description of Work

- A. This section includes furnishing all labor, materials, and equipment for the installation of all underground sewer and drainage lines, including manholes, catch basins, concrete piers, and other appurtenances and structures as required for this project.
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- B. Where special conditions exist, these will be reviewed in the field with the engineer for the determination of a proper solution.
- C. The contractor installing the underground sewer system shall be a firm specializing and experienced in this work for not less than 2 years.

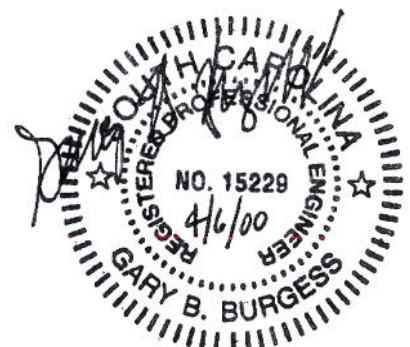
#### 1.4 Related Work Specified Elsewhere

- A. Interior Plumbing
- B. Earthwork and Site Grading

### 2 PRODUCTS

#### 2.1 Materials

- A. Concrete shall be 3000 psi mix using Portland cement (ASTM C150 Type I), sand (ASTM C33), and coarse aggregate (ASTM C33).
- B. Welded wire fabric shall conform to ASTM A185.





- C. Reinforcing bars shall conform to ASTM A615, new billet steel, intermediate grade.
- D. Water shall be clean, free from oils, acids, alkalis, or organic or deleterious substances.

## 2.2 Manholes

- A. Masonry materials for manholes are specified below. Contractor has the option to use precast concrete manhole structures with standard 4'-0" diameter conforming to ASTM C478.
- B. Common Brick: standard size 2-1/4" x 3-3/4" x 8" shale or clay, hard, sound, well burned, free from lime or other unsuitable materials, ASTM C62, Grade SW.
- C. Portland Cement: approved manufacturer, ASTM C150, Type I.
- D. Sand: ASTM C144.
- E. Lime: Hydrated, ASTM C207, Type N.
- F. Water for masonry material: free of suspended matter, injurious amounts of acids or alkalis, and containing no industrial or domestic wastes.
- G. Cast iron manhole rings, covers, steps, and inlet frames and gratings are specified on plans and shall be gray cast iron conforming to ASTM A48, Class 30B.

## 2.3 Gravity Sewer Piping

- A. Clay Pipe (VCP) for sewers and drain lines shall be extra strength conforming to ASTM C700, resilient joint, ASTM C425, Type I or III. VCP shall be installed in accordance with ASTM C12 (latest revision).
- B. Cast Iron Soil Pipe (CISP) shall conform to ANSI A21.1, A21.6, A21.8, A21.10 and/or A21.11, hub and spigot type with neoprene compression gaskets conforming to ASTM A564.
- C. Reinforced Concrete Pipe (RCP), 12 inches in diameter and larger, shall conform to ASTM C76, Class III or IV (minimum) and stronger where indicated on drawings. Joints shall be bell and spigot with mastic joint material. Grouted joints will not be permitted. (Used for storm drain lines only).
- D. Corrugated Metal Pipe (CMP) shall be fully bituminous-coated conduit conforming to AASHTO M190, helically or circumferentially corrugated, mild galvanized steel. (Used for storm drain lines only).

- E. Ductile Iron Pipe (DIP) where shown on plans shall comply with ANSI A21.50 and ANSI A21.51 with fittings complying with ANSI A21.10 and rubber gaskets complying with ANSI 21.11. DIP shall be AWWA Class "50". Push-on type joint is approved unless noted on drawings.
- F. Poly Vinyl Chloride (PVC) Pipe and fittings for sewers and drain lines shall comply with ASTM D-3034, Type PSM, SDR 35, and shall be installed in accordance with ASTM D-2321. Elastomeric gasket joints shall meet requirements of ASTM D-3212.

#### 2.4 Force Main Piping

- A. PVC force main piping shall comply with ASTM D-2241 and installation shall comply with ASTM D-2321 or ASTM D-2774.
- B. CIP and DIP force main shall comply with ASTM A-377 and installation shall comply with AWWA C-600.

### 3 EXECUTION

#### 3.1 General

- A. Contractor must examine the areas and conditions under which sanitary sewer system installation is to be performed and notify the engineer in writing of conditions detrimental to the proper and timely completion of the work. The contractor must not proceed with the work until notified by the engineer.
- B. Install conduit in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
- C. Inspect conduit before installation to detect any apparent defects. Mark defective materials with white paint and promptly remove from the site.
- D. Lay conduit beginning at the low point of a system with the bell end laid upgrade, true to the grades and alignment indicated with unbroken continuity of invert.
- E. Install gaskets in accordance with manufacturer's recommendations on the use of lubricants, cements, and other special installation requirements.
- F. Pipe installation: install all pipe in strict accordance with the manufacturer's recommendations.
- G. Joint adaptors: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.
- H. Potable Water Supply Interconnections. There shall be no physical connections between a public or private potable water supply system and a sewer, or



appurtenance thereto which may permit the passage of any sewage or polluted water into the potable supply. No potable water pipe shall pass through or come into contact with any part of a sewer manhole.

- I. Horizontal and Vertical Separation from Potable Water Mains. Sewers shall be laid at least ten (10) feet horizontally from any existing or proposed potable water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten (10) foot separation, SCDHEC may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the sewer closer to a potable water main, provided that the potable water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the potable water main is at least eighteen (18) inches above the top of the sewer.
- J. Crossings. Sewers crossing potable water mains shall be laid to provide a minimum vertical separation of eighteen (18) inches between the outside of the potable water main and the outside of the sewer. This shall be the case where the potable water main is either above or below the sewer. Whenever possible, the potable water main shall be located above the sewer main. Where a new sewer line crosses a new potable water main, a full length of pipe shall be used for both the sewer line and the potable water main, and the crossing shall be arranged so that the joints of each line shall be as far as possible from the point of crossing and each other. Where a potable water main crosses under a sewer, adequate structural support shall be provided for the sewer line to prevent damage to the potable water main while maintaining line and grade.
- K. Special Conditions. When it is impossible to obtain the distances specified in subsections I and J above, SCDHEC may allow an alternative design. Any alternative design shall:
  - 1) maximize the distances between the sewer line and the potable water main and the joints of each;
  - 2) use pipe materials which meet the requirements as specified in SCDHEC Regulation 61-58.4(D)(1) for the sewer line; and
  - 3) allow enough distance to make repairs to one of the lines without damaging the other.
- L. Force Mains. There shall be at least a ten (10) foot horizontal separation between sanitary sewer force mains and potable water mains. There shall be an eighteen (18) inch vertical separation at crossing as required in subsections I and J above.
- M. Sewer Manholes. No potable water pipe shall pass through or come into contact with any part of a sewer manhole.

- N. All sewers shall be constructed with a minimum of three (3) feet of cover, unless justified by the applicant and approved by SCDHEC.

### *3.2 Pipe Trench Excavation*

- A. All pipe trench excavation shall be "Classified".
- B. Excavation shall be classified as either "Common Excavation" or "Rock Excavation". Rock Excavation describes removal of material that cannot be removed by means other than blasting or air hammer. Materials that can be removed by ripping shall not be considered Rock Excavation. Common Excavation shall include the removal of all types of materials that do not fall into the category of Rock Excavation as directed above. The engineers shall determine classification of excavation. It shall be the contractor's responsibility to notify the engineers when rock excavation is encountered. The contractor will not be credited for any rock quantities excavated before such notice is given.
- C. If conditions are such that the blasting or any use of explosives is required, the contractor, prior to blasting, shall submit to the engineers, satisfactory evidence of blasting and explosive insurance in the amount required for bodily injury and property damage under the special conditions and shall prove to the satisfaction of the engineers the experience and capability of the contractor's organization to safely handle and perform such operations.
- D. Only qualified persons skilled in such work shall perform handling and storing of blasting materials. Adequate precautions shall be taken to prevent accidents, injury to persons, or damage to property. Qualification of blasting operations personnel and safety precautions shall be in full compliance with local codes governing such operations and shall be approved by the engineers.
- E. The trench shall be excavated by an approved method and to a depth to permit installation of the pipe along the lines and grades shown on the drawings. The width of the trench shall be sufficient to allow thorough compaction of the backfill under and around the pipe, and in no case shall be less than 18 inches greater than the outside diameter of the barrel of the pipe. Where excavation is in rock, the rock shall be removed to a depth below trench grade of at least 4 inches for pipes smaller than 30 inches in diameter, and 6 inches for pipes 30 inches in diameter and larger; and before laying the pipe, the trench shall be refilled to grade with earth, sand, gravel or other suitable material, firmly compacted to a proper bedding for the pipe.
- F. Any trench exceeding a height of four feet shall be sloped, benched or sheeted and shored to maintain the stability of the trench wall. No greater length of trench in any location shall be left open in advance to the complete work than shall be authorized by the engineer. During excavation, materials suitable for backfill shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and prevent slides or cave-ins. If suitable



bearing for the pipe or conduit is not encountered at the depth indicated for trench bottom due to wet or unstable material, such material shall be excavated to depth required and refilled and compacted to proper grade with coarse sand, fine gravel, or other suitable approved material.

- G. All changes of direction shall be made with standard manholes or cleanouts, unless otherwise shown. Maximum deflection for pipe joints shall be in accordance with manufacturers recommendations. All intersecting lines shall connect with standard fittings.
- H. The contractor shall do all necessary bracing and bridging to maintain traffic during construction through areas affected by trenching.

### *3.3 Bracing and Sheeting*

Wherever necessary to prevent caving, excavations shall be adequately sheeted and braced and the trench width shall be increased accordingly. Trench sheeting shall remain in place until the pipe has been tested and backfilled to a depth of two feet over the top of the pipe. The contractor shall leave sheeting and shoring in place where directed by the engineers or the inspecting county authority.

### *3.4 Pumping*

The contractor shall perform all pumping necessary for de-watering trenches and to provide proper work conditions for installation of pipe and appurtenances.

### *3.5 Pipe Bedding*

- A. The bottom of trenches shall be shaped in undisturbed soil, in material placed due to the excavation of muck, or in the bedding required on the drawings.
- B. The entire bottom of the excavations shall be firm, stable, and at a uniform density, and unless for removal of rock or muck, left undisturbed. Joint holes shall be excavated by hand to the minimum size required for proper installation of the joint so the joint does not carry the weight of the pipe.
- C. Preparation of the trench bottoms, including the required excavation and tamped backfill, shall be performed according to Class A, Class B, or Class C bedding.
  - Class A Bedding: Class A Bedding shall consist of concrete cradles poured to the full width of the trench, pipe shall be laid to line and grade on concrete or wood blocking and joints shall be made before the concrete is poured. Care shall be taken to prevent movement of the pipe while the concrete is being poured.
  - Class B Bedding: An approved, compacted, crushed stone bedding material shall be placed under and around the pipe as shown on the plans. The bedding material shall extend for the full width of the trench.

- Class C Bedding: Class C Bedding shall be a shaped trench bottom with bell holes.

### 3.6 Pipe Laying

- A. Batter boards shall be set by contractor at all angles or manholes and at intervals between of not over 50 feet; all pipe shall be plumbed from a line between batters. A minimum of three batters shall be used in any straight line.
- B. All grades shown as pipe elevations are, unless otherwise noted, to the bottom of inside of pipe.
- C. Before the pipe is placed in the trench, the bottom and sides of the trench shall be carefully prepared as shown on the plans and bracing and sheeting installed where required.
- D. Shape trench bottoms and bedding materials shall be prepared as shown on the plans to give uniform support for the full length of the pipe. Shaped trench bottoms shall be prepared in firm, stable, ground and bedding materials shall be placed in firm stable trench subgrades. The contractor shall notify the engineer immediately if soft, mucky or otherwise unsuitable materials are encountered at or below the pipe or bedding level. The engineer may order the contractor to stabilize the trench bottom with crushed stone, or to undercut the ditch and refill the trench bottom to grade with compacted crushed stone.
- E. Approved electronic alignment devices may be used in lieu of batter boards in Section A as per approval of the engineer. All devices must meet with all applicable codes and safety precautions.
- F. Pipelines shall be kept cleaned out as the laying progresses and open ends kept securely stopped. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags and other foreign matter removed from the interior.
- G. Trench backfilling shall begin immediately, after the pipe has been laid. Unless otherwise directed, the pipe shall be inspected by the engineer before backfilling begins.

### 3.7 Backfilling:

- A. Immediately after the pipes have been laid, the trench shall be backfilled around the barrel of the pipe with fine material, free from large stones, deposited in level layers not more than 6 inches in depth, each layer to be thoroughly tamped and compacted before the next layer is deposited.



- B. This filling shall be made along the barrel of the pipe only, to at least the mid-diameter of the pipe but not more than the top of the pipe, and the filling shall be kept away from the joints until the joints have been inspected and all necessary caulking or other repairs to joints made.
- C. After joints are inspected, trenches shall be backfilled, using fine material up to 18 inches above top of pipe, placed in 6-inch layers and thoroughly tamped. Balance of backfill may be placed with the aid of dump trucks, bulldozers, crane or other approved methods. Where pipeline is located under paved roads or streets, the backfill shall be consolidated in such a manner as to provide as unyielding foundation for the paving, and excess materials shall be removed.
- D. Succeeding layers of backfill above the hereinbefore specified 18", may contain coarser materials, and shall be free from brush or any other perishable or objectionable matter that would prevent proper consolidation or that might cause subsequent settlement, and shall be compacted thoroughly by puddling with hose and long pipe nozzle, or by tamping. It is important that proper precautions be taken to prevent floating of the pipe when puddling the trench, and the contractor shall be wholly responsible for neglect of these precautions. The engineers or inspecting county authority will decide on methods of consolidating to be followed on each part of the work.
- E. No rock or boulders shall be used in the backfill for at least one foot above the top of the pipe and no stone larger than 6 inches in its greatest dimension shall be used in the backfilling.
- F. Where it is important that the surface of the backfill be made safe for vehicular traffic as soon as possible, or where a permanent pavement is to be placed within a short time, the upper 12 inches of backfill shall be approved moist material, thoroughly compacted in thin (about 4 inch) layers by tamping, shall comply with requirements of Section 2B1 of the specifications.
- G. Any deficiency in the quantity of material for backfilling the trenches, or for filling depressions caused by settlement, shall be supplied by the contractor.
- H. The contractor shall repair all paving of roads or driveways that are damaged by the work or the contractor's operations under this contract, to the satisfaction of the engineers.
- I. Backfill of all trenching under proposed and existing right-of-way limits shall be compacted throughout the entire depth of the trench. All other trenching shall be overfilled with excess material to provide for settlement.

### *3.8 Manholes:*

- A. Manholes shall be clay, brick or precast sections. Sizes, shapes, dimensions, and locations shall be as shown on the drawings or as otherwise directed by the engineer. The height or depth of the manhole will vary with the location, but unless shown otherwise on drawings, shall be such that the top of the manhole frame will be at the finished grade of the pavement or ground surface and the invert will be at the design elevations.
- B. Where the difference in the invert elevations of a sewer 18 inches in diameter or smaller and any other sewer intersection in one manhole is 2 feet or more, a drop manhole shall be constructed as shown on the drawings.
- C. Manhole top elevations shall be greater than or equal to the fifty (50) year flood elevation unless watertight covers are provided.

### *3.9 Headwalls and Drainage Structures:*

- A. Headwalls, concrete piers, and structures shall be constructed as shown on drawings of 3000-pound concrete, or precast structures may be used when reviewed and approved by the engineers.

### *3.10 Special Safety Requirements:*

- A. All trenches shall be completely backfilled at end of workday. Temporary bridges and crossings shall be maintained by the contractor until backfill adjacent to the bridge or be taken when backfilling around existing utilities. Any damage caused to existing utilities during backfilling operations shall be promptly repaired at no cost to the owner. All temporary protective and support systems installed on existing utilities shall remain in place until they can be supported and protected by the trench backfill. All workmen shall be out of the trench in the areas where backfill material is being placed in the trench by clamshell buckets or backhoe. Under no circumstances shall backfill materials be transported to the trench over workmen.

### *3.11 Testing and Cleaning:*

- A. After completion of any section of sewers and appurtenances the pipe, joints, and alignment shall be true to line and grade. Joint surfaces shall be smooth. There shall be no visual leakage and the sewer shall be completely free from any cracks. The sewer shall be clean on the inside and free from protruding joint materials, deposits of sand, mortar, earth or other materials or debris on the inside. Sewer lines and manholes shall be flushed and washed down, if requested by the engineer.



- B. Infiltration or exfiltration shall not exceed 200 gallons per 24 hours per inch of diameter per mile of sewer. The contractor shall make infiltration tests as directed by the engineer when the groundwater level is 18 inches or more above the top of the pipe.
- C. When normal groundwater is not at a level to permit infiltration test, the contractor may be required to make exfiltration tests at the discretion of the engineer. The tests may be made by filling the pipe or sections thereof with water to head of two feet above the top of the pipe and observing the amount of water required to maintain this level.
- D. Low-pressure air test may be used in lieu of the exfiltration test specified above. Air testing shall conform to ASTM F-1417 (Plastic Pipe).
- E. There shall be no active leakage or seepage at manholes.
- F. All labor, materials, equipment water, services required for cleaning and testing shall be provided by the contractor and at the expense of the contractor. No separate payments will be made to the contractor for cleaning or testing under either unit price or lump sum contracts.
- G. Sewer lines and appurtenances will not be considered ready for acceptance until all provisions of the contract documents have been met, until all tests have been satisfactorily made, until final inspection of the work has been made by the engineer, and until all defects have been corrected to the satisfaction of the engineer. In case infiltration or exfiltration exceeds the specified rates, the sewers shall be repaired by the contractor at no cost to the owner until they will comply with the specified rates. Any defects determined during inspections by the engineer shall be corrected by the contractor to the satisfaction of the engineer and at no cost to the owner.

### *3.12 Force Mains:*

- A. For force mains, thrust blocking, or restraint joints shall be provided at all changes in alignment greater than or equal to 30 degrees.
- B. An automatic air relief valve shall be placed at high points in the force main sewer to prevent air locking.
- C. Design and construction of force mains shall be such that they satisfy a leakage test in accordance with AWWA C-600 (DIP) or AWWA C-605 (PVC).

### *3.13 Pavement Replacement:*

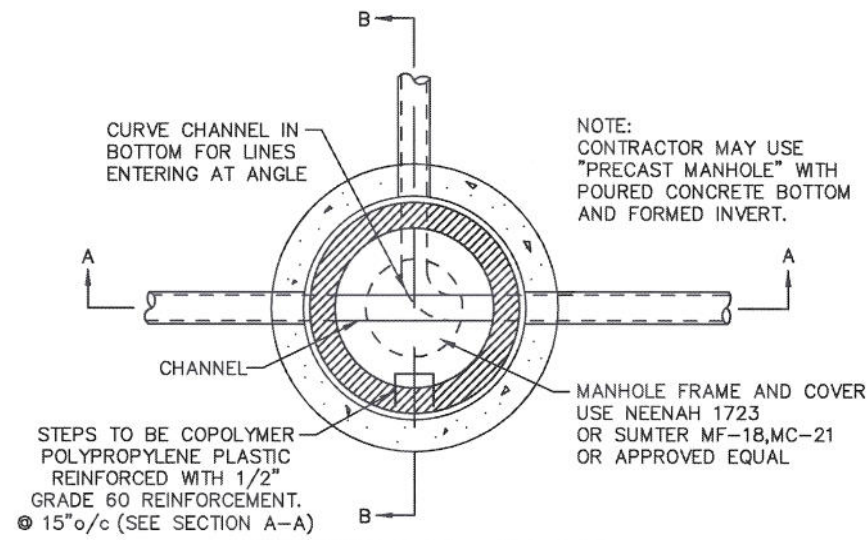
- A. All concrete sidewalks, asphalt pavement and curb gutter that is removed or damaged by construction shall be restored and replaced with new materials to at least the original condition as detailed on the drawings and to the satisfaction of the agency having jurisdiction.

*3.14 Cleaning Up:*

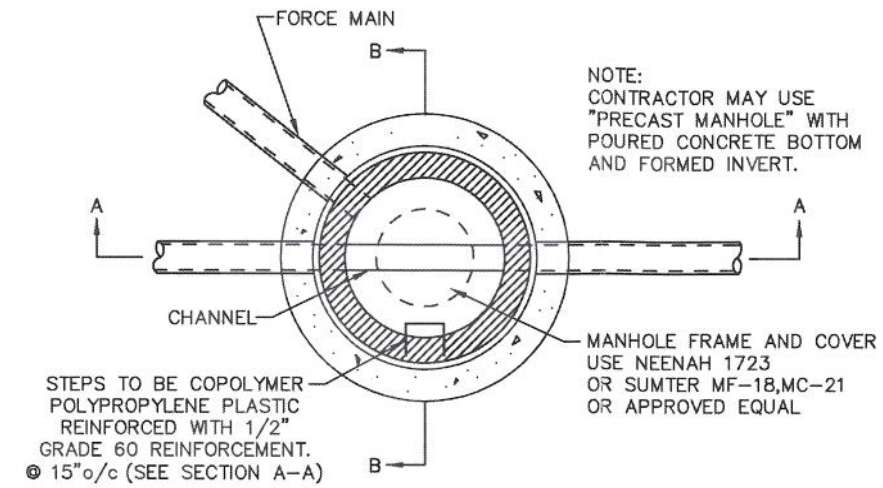
- A. The contractor shall remove all excess material from excavations to points designated by the engineers, and clean the site of the work of all debris collected during the construction.

End of Section 2J1

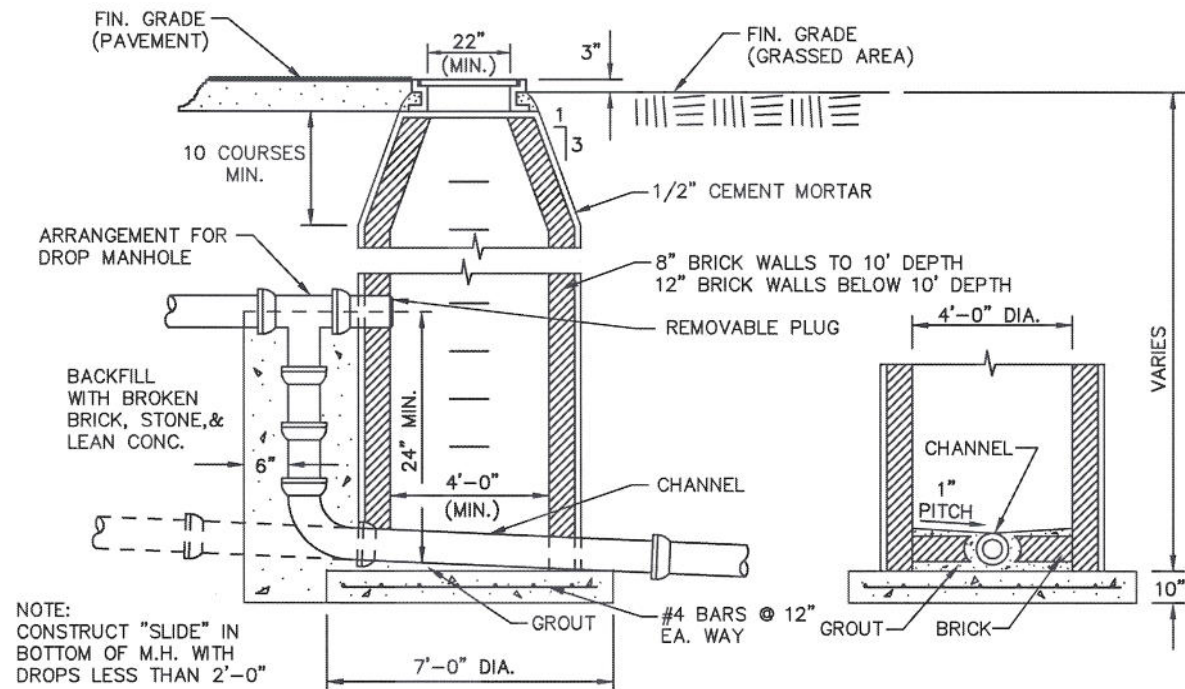




SECTIONAL PLAN



SECTIONAL PLAN

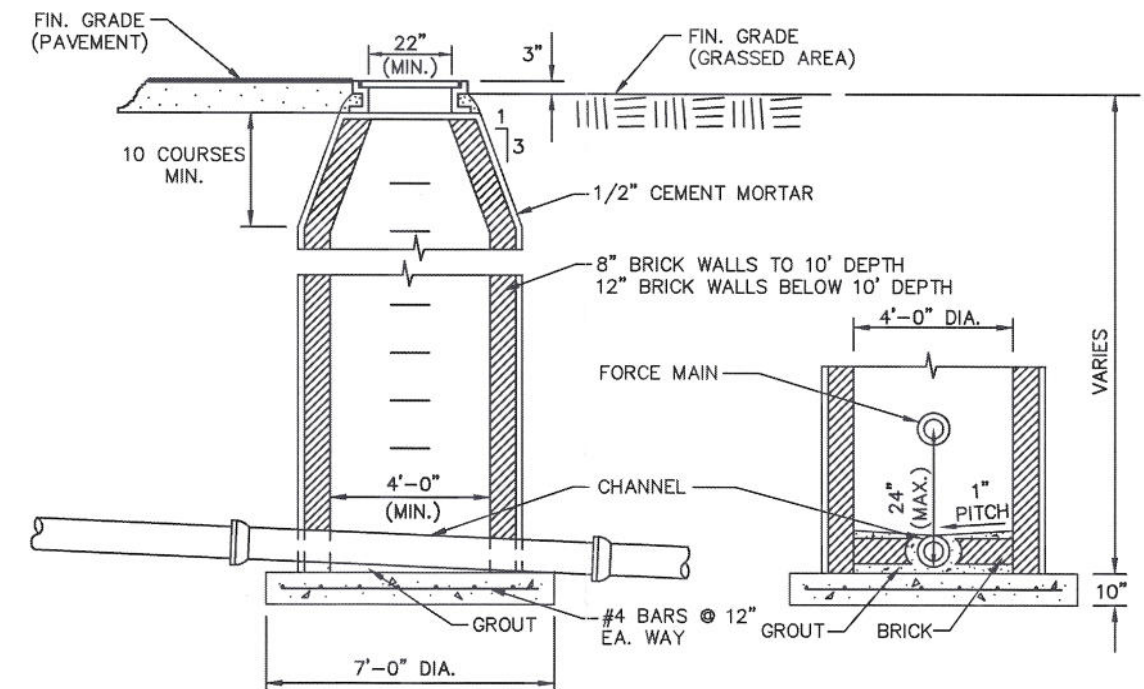


SECTION A-A

SECTION B-B

TYPICAL SANITARY SEWER MANHOLE

(N.T.S.)

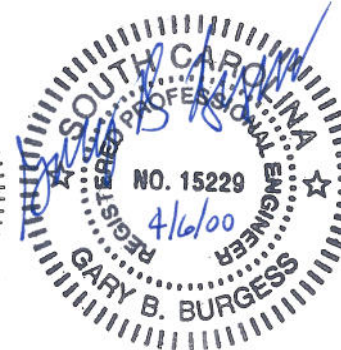


SECTION A-A

SECTION B-B

TYPICAL SANITARY SEWER MANHOLE

(N.T.S.)



## SECTION 33 40 00 - STORMWATER UTILITIES

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Work under this section shall consist of providing all labor, plant facilities, materials, tools, equipment, shop drawings and supervision necessary and required to install all of the storm drainage facilities, including piping, fittings, structures, bedding, and backfilling, as specified in accordance with the contract documents.
- B. Reference Survey and Layout specification section for information on necessary as-built to be provided by the Contractor.

#### 1.02 REFERENCED SECTIONS

- A. Section 31 23 17 – Trenching and Excavation

#### 1.03 REFERENCE STANDARDS

- A. American Society For Testing and Materials (ASTM)
  - 1. A185 – Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
  - 2. A615 – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  - 3. A760 – Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
  - 4. A798 – Installation of Corrugated-Steel Pipe for Sewers and Other Applications
  - 5. A929 – Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
  - 6. C76 – Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - 7. C478 – Precast Reinforced Concrete Manhole Sections
  - 8. C913 – Precast Concrete Water and Wastewater Structures
  - 9. C1479 – Installation of Reinforced Concrete Pipe
  - 10. C990-01A – Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
  - 11. D2321 – Installation of Thermoplastic Pipe for Sewer/Gravity-Flow Applications
  - 12. D3034 – Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
  - 13. D3212 – Joints for Drain and Sewer Plastic Pipes Using Elastomeric Seals
  - 14. F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe
  - 15. F794 – Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
  - 16. F949 – Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
- B. American Association of State Highway and Transportation Officials (AASHTO)
  - 1. M198 – Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
  - 2. M252 – Corrugated Polyethylene Drainage Tubing
  - 3. M274 – Aluminum-Coated (Type 2), for Corrugated Steel Pipe
  - 4. M294 – Corrugated Polyethylene Pipe.
  - 5. M36 – Metallic Coated Corrugated Steel Culverts and Underdrains
  - 6. M190 – Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
  - 7. M199 – Standard Specification for Precast Reinforced Concrete Manhole Sections
- C. American Water Works Association (AWWA)
  - 1. C110 – Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (75 mm through 1200 mm), for Water and Other Liquids (revision of ANSI/AWWA C110/A21.10-93)
  - 2. C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings



3. C151 – Ductile-Iron Pipe, Centrifugally Cast, for Water
- D. American Concrete Institute (ACI)
  1. 301 – Structural Concrete for Buildings, Specifications for
  2. 318 – Building Code Requirements for Structural Plain Concrete
- 1.04 PROJECT RECORD DOCUMENTS
  - A. Accurately record as-built locations of pipe runs, connections, catch basins, cleanouts, top elevations and invert elevations.
  - B. Identify and describe unexpected variations of subsurface conditions and location of any utilities encountered.
- 1.05 QUALITY ASSURANCE
  - A. All costs related to reinspection due to failures shall be paid for by the Contractor at no additional expense to the Owner. Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide full access to site for inspection activities.
- 1.06 PROJECT CONDITIONS
  - A. Removal/Relocation of Existing Utilities: The contractor shall be responsible for removal and/or relocation of existing utilities, whether shown or not shown on the drawings, at locations where conflicts occur with proposed storm drainage improvements at no additional cost to the owner.
- 1.07 SUBMITTALS
  - A. The General Contractor and the Subcontractor shall execute the Conformance Submittal(s) at the end of this section.

## PART 2 - PRODUCTS

- 2.01 PIPES AND FITTINGS
  - A. Reinforced Concrete Pipe (RCP)
    1. ASTM C76, Class III unless otherwise noted on drawings; and,
    2. Butyl mastic sealant shall meet the requirements of ASTM C990-01a or AASHTO M198 for Type B flexible plastic gaskets.
  - B. High Density Polyethylene Pipe (HDPE) Smooth Interior
    1. Pipe and fittings shall conform to AASHTO M252 and M294;
    2. Rubber gaskets shall meet the requirements of ASTM F477 with joints conforming to ASTM D3212; and,
    3. Maximum permitted diameter of 24 inches and only where indicated on drawings; and,
    4. Approved pipe and manufactures:

ADS – “N12 Pro Link WT” Pipe Advance Drainage Systems, Inc. 3300 Riverside Drive Columbus, Ohio 43221 (614) 457-3051
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- C. Bituminous Coated Corrugated Steel (Metal) Pipe and Pipe Arch (BCCMP/BCCMA)
    - 1. Pipe shall meet the requirements of ASTM A760 or AASHTO M36 and be fully bituminous coated in accordance with AASHTO M190;
    - 2. The minimum gage for pipe materials shall be 16 gauge for diameters of 10-24 inches, 14 gage for diameters of 30-48 inches, 12 gage for diameters of 54-96 inches and 10 gage for diameters of 102 inches and larger, but not less than the gage otherwise indicated on the drawings;
    - 3. Each pipe shall be clearly marked to show class or gauge, date of manufacture, and name or trademark of the manufacturer; and,
    - 4. Joints for corrugated metal pipe, pipe arches and fittings shall be outside collars or coupling bands of galvanized steel angles riveted near the ends and bolted through angles to draw the bands tight.
  - D. Aluminized Steel Type 2 Corrugated Steel Pipe
    - 1. Pipe shall meet the requirements of ASTM A929 or AASHTO M274;
    - 2. May be used in lieu of BCCMP and shall meet the requirements of Article 2.01(C 2-4) noted above; and,
    - 3. Externally Ribbed Pipe, such as “ULTRA FLO” shall not be permitted.
  - E. Polyvinyl Chloride Pipe (PVC)
    - 1. Pipe shall meet the requirements of ASTM D3034, SDR 35; and,
    - 2. Rubber gaskets shall meet the requirements of ASTM F477 with joints conforming to ASTM D3212.
  - F. Corrugated Polyvinyl Chloride Pipe
    - 1. Pipe shall meet the requirements of ASTM F949 and F794;
    - 2. Rubber gaskets shall meet the requirements of ASTM F477 with joints conforming to ASTM D3212; and,
    - 3. Approved Manufacture: Contech “A2000”, 1001 Grove Street, Middletown, OH 45044, (336) 854-2177.
  - G. Ductile Iron Pipe (DIP)
    - 1. Pipe shall meet the requirements of AWWA C151; and,
    - 2. Fittings shall meet the requirements of AWWA C110 with rubber gaskets conforming to AWWA C111.
  - H. Subdrains
    - 1. Shall be perforated PVC or HDPE; and,
    - 2. Installation shall be in accordance with the details and at the locations shown on the drawings.
- 2.02 DRAINAGE STRUCTURES, DROP INLETS, CATCH BASINS, MANHOLES AND JUNCTION BOXES (All structures shall be precast unless otherwise approved by the Owner)
- A. Structures:
    - 1. Precast Concrete Drainage Structures;
      - a. Standard-duty non-traffic rated (H20) conforming to ASTM C478 or ASTM C913.
    - 2. Cast In-Place Concrete Drainage Structures; and,
      - a. Standard-duty non-traffic rated in accordance with Department of Transportation Standards.
    - 3. Solid concrete Brick Masonry.
      - a. Standard-duty non-traffic rated in accordance with Department of Transportation Standards.

- B. Cast Iron Frames, Hoods, and Grates per details shown on drawings. Provide 6 inch thick rectangular concrete apron, with 18 inch minimum width measured from the edge of structure frame to the end of concrete apron, around all structure frames in asphalt pavement areas. Provide saw cuts from each corner of the concrete apron to the frame of structure.
  - C. Steps
    1. Shall meet the requirements of AASHTO M199 for design, materials, and dimensions;
    2. Built into the walls of all structures over 3 feet 6 inches in height; and,
    3. Steps shall be 16 inches on center with lowest step being no more than 16 inches from the bottom.
  - D. Reinforcement
    1. Deformed reinforcing bars, grade 40 or 60, meeting the requirements of ASTM A615; and,
    2. Wire fabric meeting the requirements of ASTM A185.
- 2.03 CLEANOUTS & PLUGS
- A. Installation shall be in accordance with the details and at locations shown on the drawings.
- 2.04 MISCELLANEOUS
- A. Headwall: Construction shall be in accordance with details shown on drawings and concrete shall be in accordance with Article 2.06 of this section.
  - B. Stone Rip-Rap: Meeting State DOT specifications, and unless noted otherwise on drawings, shall have a median stone size of 6 inches. All rip-rap shall be installed over a medium weight non-woven geotextile fabric.
  - C. Concrete Lined Channels: Construction shall be in accordance with details shown on drawings and concrete shall be in accordance with Article 2.06 of this section.
  - D. Flared-End Sections: Meeting State DOT specifications unless otherwise noted on drawings.
- BEDDING AND BACKFILL MATERIAL
- E. Where the foundation material is found to be of poor supporting value or of rock, the Owner may make minor adjustments in the location of the pipe to provide a more suitable foundation. Where this is not practical, the foundation shall be conditioned by removing the existing foundation material by undercutting to the depth as directed by the geotechnical engineer and backfilling with either a suitable local material secured from unclassified excavation or borrow excavation at the nearest accessible location along the project, or foundation conditioning material consisting of crushed stone or gravel or a combination of sand and crushed stone or gravel approved by geotechnical engineer as being suitable for the purpose intended. The selection of the type of backfill material to be used for foundation conditioning will be made by the geotechnical engineer.
- 2.05 CONCRETE
- A. No concrete or masonry shall be placed when the temperature is below 40 degrees Fahrenheit, or when indications are for lower temperatures within 24 hours, unless protection of concrete and masonry is approved by the Owner. Damage to the structure because of freezing shall be corrected by the Contractor at his own expense, to the satisfaction of the Owner.
  - B. Concrete shall conform to ACI 301 and applicable referenced specifications and shall have a 28 day compressive strength of 4,000 psi.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. The Contractor shall install all drainage structures and pipe in the locations shown on the drawings and/or as approved by the Owner. Pipe shall be of the type and sizes specified on the drawings and shall be laid accurately to line and grade. Structures shall be accurately located and properly oriented.
- B. Excavation and Backfill – The provisions in Section 31 23 17, Trenching and Excavation shall govern all work under this Section.
- C. Storage and Handling of Pipe – All pipe shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of pipe on the job shall be in accordance with the pipe manufacturer's recommendations.
- D. Damage to Pipe
  - 1. Pipe which is defective from any cause, including damage caused by handling, and determined by the Owner as unrepairable, shall be unacceptable for installation and shall be replaced at no cost to the Owner and as directed by the Owner; and,
  - 2. Pipe that is damaged or disturbed through any cause prior to acceptance of the work, shall be repaired realigned or replaced as directed by the Owner, at the Contractor's expense.
- E. Manholes, catch basins and drain inlets shall be constructed as soon as the pipe laying reaches the location of the structures. Should the Contractor continue his pipe laying without making provisions for completion of the structures, the Owner shall have the authority to stop the pipe laying operations until the structure is completed.
- F. Any structure, which is mislocated or oriented improperly, shall be removed and re-built in its proper location, alignment and orientation at the Contractor's expense.

### 3.02 BEDDING

- A. Bedding material, when required, shall be in accordance with Section 31 23 17, Trenching and Excavation for work described within this Section.

### 3.03 PIPE INSTALLATION

- A. Comply with Section 31 23 17, Trenching and Excavation
- B. Laying Pipe
  - 1. Unloading and Handling: All pipes shall be unloaded and handled with reasonable care. Pipes shall not be rolled or dragged over gravel or rock during handling. The Contractor shall take necessary precautions to ensure the method used in lifting or placing the pipe does not induce stress fatigue in the pipe and the lifting device used uniformly distributes the weight of the pipe along its axis or circumference;
  - 2. Each length of pipe shall be inspected for defects and cracks before carefully lowered into the trench. Any damaged or any pipe that has had its grade disturbed after laying shall be removed and replaced. Bituminous coated pipe shall be handled with special care and repair of damaged coating shall conform with AASHTO M190;
  - 3. Lay pipe on prepared foundation starting at the downgrade end according to line and grade with the necessary drainage structures, fittings, bends and appurtenances as shown on the drawings. Rigid pipes shall be laid with the bell or groove ends upgrade with the spigot or tongue fully inserted. Flexible pipes shall be laid with the inside circumferential laps pointing downstream and with the longitudinal laps at the side or quarter points. Reinforced concrete pipe shall be installed in accordance with ASTM C1479. Bituminous coated corrugated steel pipe and arch pipe shall be installed in accordance with ASTM A798. HDPE pipes shall be installed in accordance with pipe manufacture's installation guidelines for heavy duty drainage applications and ASTM D2321; and,

4. Pipe sections shall be firmly joined together with appropriate gaskets or bands.
- 3.04 DROP INLET, CATCH BASIN, MANHOLE, AND JUNCTION BOX INSTALLATION
- A. Precast Drainage Structures
    1. Structure units shall be assembled in accordance with the manufacturer's instructions to form a sound structural unit.
  - B. Cast in Place Drainage Structures
    1. Structures shall be installed in accordance with the details or referenced specifications shown on the drawings; and
    2. Concrete shall comply with requirements of Article 2.06 of this section.
  - C. Solid Concrete Brick Masonry Structures
    1. Structures shall be installed in accordance with the details or referenced specifications shown on the drawings;
    2. Only solid masonry units shall be utilized;
    3. Minimum wall thickness shall be 8 inches; and,
    4. Minimum bottom slab thickness shall be 6 inches and extended a minimum of 6 inches outside the structure.
  - D. Fittings and Connections
    1. Pipe connections shall be made so that the pipe does not project 3 inches beyond the inside wall of the drainage structure, and shall be grouted as necessary to make smooth and uniform surfaces on the inside of the structure. Boxes to have bottoms filled with concrete to provide a bench between pipe inverts.
  - E. Frames, Grates and Hoods
    1. Shall be set to 8" below finished grade in accordance with the drawings;
    2. Firmly embedded in mortar approximately 1 inch thick and aligned to fit the top section of the structure; and,
    3. Brick set in mortar used to adjust the frame to finished grade shall be limited to no more than four courses for precast structures and have a minimum wall thickness of 8 inches.
  - F. Interface with Existing Facilities
    1. Compliance with Facility Owner Requirements: Connections made into existing drainage facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor will be required to comply with all such requirements, including securing of all required permits, and paying the costs thereof. The cost of making the connections in accordance with the requirements of the Owner of the existing facility shall be included in the Contract Sum; and,
    2. Requirements: The Contractor shall make all required connections of the proposed drainage facilities into existing drainage facilities, where and as shown on the Drawings and/or as approved by the Owner.
- 3.05 CONSTRUCTION WITHIN THE PUBLIC R.O.W.
- A. Construction within the public right-of-way shall conform to all requirements of the regulatory authority having jurisdiction.
- 3.06 MODIFICATIONS OF EXISTING STRUCTURES
- A. General: The Contractor shall alter, reconstruct and/or convert existing structures where and as shown on the drawings, and/or as approved by the Owner. In general, alterations shall be performed with the same type of material used in the original construction unless otherwise indicated on the drawings or approved by the Owner.

- B. Damage to Existing Installations: The Contractor shall exercise extreme care during such alteration, reconstruction and/or conversions so as not to damage any portions of the structure and/or pipe shown to remain. Any such damage shall be repaired by the Contractor at his own expense and to the satisfaction of the Owner.

3.07 ROOF DRAINS AND LEADERS

- A. The Site Contractor shall install roof downspout leaders as provided on the drawings to within 5 feet of building limits. If work by others is complete then the Contractor shall complete the connection. If future connections will be required by others, Contractor shall install plugging and material apparatus as necessary to protect and mark his work.
- B. All piping connections shall utilize a prefabricated fittings or drainage structure.

3.08 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.09 PROTECTION AND CLEANING

- A. The Contractor shall maintain all pipe installations and drainage structures in a condition such that they will function continuously and shall be kept clean of silt, debris and other foreign matter from the pipe and drainage structure is installed until the project is accepted.

3.10 FINAL INSPECTION

- A. Upon completion of the work and before final acceptance by the Owner, the entire drainage system shall be subject to a final inspection in the presence of the Owner and/or Site Engineer. The work shall not be considered as complete until all requirements for line, grade, cleanliness, and workmanship have been completed.

END OF SECTION 33 40 00

**CONFORMANCE SUBMITTAL**

**SECTION 33 40 00 – STORM DRAINAGE**

Land Planning Associates,  
Inc. \_\_\_\_\_

General Contractor: \_\_\_\_\_  
(Company Name, Phone Number)  
\_\_\_\_\_  
(Address)

Sub-Contractor: \_\_\_\_\_  
(Company Name, Phone Number)  
\_\_\_\_\_  
(Address)

The following products have been selected (check one box) for use in this project from the list of acceptable products specified:

Concrete Pipe, ASTM C76, Butyl mastic joint sealant ASTM C990-01a or AASHTO M198 for Type B flexible plastic gaskets:

- ☐ Tongue and Groove RCP, Class \_\_\_\_\_  
☐ Bell and Spigot RCP, Class \_\_\_\_\_

High Density Polyethylene (HDPE) Pipe, AASHTO M252, M294, Rubber Gasket Joints ASTM F477:

- ☐ ADS “N12 Pro Link WT” Pipe  
☐ Hancor “Blue Seal” Pipe  
☐ Lane “Type S Lok-Tite” Pipe  
☐ All underground connections will be made with pre-fabricated HDPE fittings

Polyvinyl Chloride (PVC) Pipe, Rubber Gasket Joints ASTM F477:

- ☐ PVC Pipe, ASTM D3034, SDR 35  
☐ Corrugated PVC Pipe, Contech “A2000”  
☐ All underground connections will be made with pre-fabricated PVC fittings

Corrugated Steel Pipe (CSP), AASHTO M252, M294, Rubber Gasket Joints ASTM F477:

- ☐ Bituminous Coated Corrugated Steel Pipe  
☐ Aluminized Corrugated Steel Pipe, Type 2

Ductile Iron Pipe (DIP), AWWA C151, Fittings AWWA C110, Gaskets AWWA C111:

- ☐ DIP

Drainage Boxes (Must be pre-cast unless approved by Owner):

- ☐ Pre-cast Concrete , per specifications by : ☐Owner, ☐DOT # \_\_\_\_\_, ☐City # \_\_\_\_\_,  
☐other \_\_\_\_\_
- ☐ Cast-in-place Concrete, per specifications by: ☐Owner, ☐DOT # \_\_\_\_\_, ☐City # \_\_\_\_\_,  
☐other \_\_\_\_\_
- ☐ Solid Concrete Brick Masonry, per specifications by: ☐Owner, ☐DOT # \_\_\_\_\_,  
☐City # \_\_\_\_\_, ☐other \_\_\_\_\_

Cast Iron Frames, Grates, and Hoods:

Manhole lids, per specifications by: ☐Owner, ☐DOT # \_\_\_\_\_, ☐City # \_\_\_\_\_, ☐other \_\_\_\_\_

Curb Inlets, per specifications by: ☐Owner, ☐DOT # \_\_\_\_\_, ☐City # \_\_\_\_\_, ☐other \_\_\_\_\_

Drop Inlets, per specifications by: ☐LPA \_\_\_\_\_, ☐DOT # \_\_\_\_\_, ☐City # \_\_\_\_\_, ☐other \_\_\_\_\_

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I represent to Land Planning Associates that the products selected will be installed in compliance with the applicable codes for the authorities having jurisdiction and in accordance with the contract documents. If noncompliance is discovered the General Contractor shall make or cause to be made all necessary corrections to meet the applicable codes and specifications. Immediately or as directed by LPA the work shall be completed without additional cost to the Owner and / or the contract.

Sub-Contractor:

\_\_\_\_\_  
(Signature of the Authorized Agent of the Sub-Contractor) Date

\_\_\_\_\_  
(Print Name of the Authorized Agent of the Sub-Contractor)

General Contractor:

\_\_\_\_\_  
(Signature of the Authorized Agent of the General Contractor) Date

\_\_\_\_\_  
(Print Name of the Authorized Agent of the General Contractor)